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IN THE

Supreme Court of the United States

OCTOBER TERM, 1962

No. 709

KENITE CORPORATION, *Petitioner*

v.

THE UNITED STATES OF AMERICA

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

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Petitioner prays that a writ of certiorari be issued to review the judgment of the United States Court of Claims, entered June 6, 1962, petitions for reconsideration of which were denied on October 3, 1962.

OPINION BELOW

The opinion of the Court of Claims (Appendix A) is not yet reported.

JURISDICTION

The Judgment of the Court of Claims was entered on June 6, 1962 (Appendix B). Petitions for reconsideration of said judgment filed by petitioner on June 13, 1962, and by the United States on July 3, 1962, were denied by the Court of Claims on October 3, 1962 (Appendix D). The jurisdiction of this Court is invoked under 28 U.S.C. § 1255.

QUESTION PRESENTED

1. Has petitioner been deprived of "just compensation" under the Fifth Amendment where the Court below valued petitioner's 1,054 acres, containing 1,563,080 proven tons of diatomite reserves of the highest quality, at the price paid to farmers and other non-producers for undeveloped and unproven diatomite land, rather than the value of such lands and deposits to petitioner, a producer of diatomite products, which had a plant located at its deposits and which was engaged in the profitable production and sale of diatomite products from those tracts?

2(a). Did the Court of Claims apply the standards of just compensation enunciated in *Mitchell* v. *United States*, 267 U.S. 341 (1925), and *United States* v. *Virginia Electric and Power Co.*, 365 U.S. 624, 633 (1961)?

2(b). If not, should the Court of Claims follow a different standard of valuation than the other federal courts?

CONSTITUTIONAL PROVISION INVOLVED

The relevant Constitutional provision involved is the last clause of the Fifth Amendment to the Constitution of the United States, which provides:

> "No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the Militia, when in actual service in time of War or public danger; nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation."

STATEMENT OF THE CASE

From October 5, 1948, to June 30, 1958, petitioner was engaged in the mining, processing and sale of diatomite products from its 1,054 acres in Grant County, Washington (Fdgs. 4, 5 and 6), and during that period had gross sales of 76,556 tons of diatomite products, from crude obtained from those lands, for $2,594,550.43. (Fdg. 2).

Diatomite deposits consist of great multitudes of microscopic silica skeletons of diatoms. Composed of numerous hollow cells of varying shapes, diatomite is highly porous and absorptive, a poor conductor of heat, electricity and sound, and resistant to heat and chemicals. Petitioner sold its finished diatomite products to various commercial enterprises to be used as filter aids, fillers, absorbents, brighteners, carriers and insulating products. (Fdg. 19; Appendix A, p. 1).

The Court of Claims held that the United States was liable for the taking of petitioner's 1,054 acres, containing 1,563,080 tons of diatomite reserves, and rendered judgment therefor in the amount of $30,000. (Appendix A and B). The Court found that due to the construction and operation of the Columbia Basin Project by the United States, petitioner's diatomite deposits became wetted and soaked to the extent that it became impossible to process the crude into finished products, thereby rendering such crude "economically valueless". (Appendix A, pp. 2 and 3; Fdgs. 67, 96 and 107). The highest and best use of petitioner's lands was as a source of diatomite up to the time that petitioner's deposits were wetted and soaked. (Fdg. 107).

ARGUMENT

The decision of the court below with respect to the evaluation of petitioner's mineral deposits totally ignores the principles of what constitutes "just compensation" under the Fifth Amendment as set forth by this Court on a multitude of occasions, as followed by the lower federal courts in a myriad of decisions, and as heretofore enunciated by the Court of Claims itself.

The sole witness for the government on evaluation, who "had never engaged in the mining, milling, or sale of diatomaceous earth products", testified that he based his evaluation of $29,625 in 1952 and $31,661 in 1959, on a per acre basis, using as his only criterion the amount that farmers and other non-producers had been paid per acre for their undeveloped land containing diatomite of unproven quality and quantity in other States and at times removed from the date of taking herein. (Fdg. 110). It was upon such testimony alone that the Court of Claims based its award of $30,000. (Appendix A, p. 3, fn. 5). The witness did not inquire of diatomite producers as to what they considered their deposits to be worth after they had established a plant at the deposits and commenced the production and profitable sale of the products derived therefrom.

Where, as here, the means of processing and marketing have been brought to and operated upon a mineral deposit, the value of the land becomes that of the mineral deposit developed. To disregard what other producers would have sold their producing land for destroys the concept of "just compensation" in this case. "It is the owner's loss, not the taker's gain which is the measure of the value of the property

taken." (*United States* v. *Causby*, 328 U.S. 256, 261 (1946)). As this Court said in *Mitchell* v. *United States*, 267 U.S. 341, 344-345 (1925):

> "The special value of land due to its adaptability for use in a particular business is an element which the owner of land is *entitled*, under the Fifth Amendment, to have considered in determining the amount to be paid as the just compensation upon a taking by eminent domain." (Emphasis added).

And, in *United States* v. *Virginia Electric and Power Co.*, 365 U.S. 624, 633 (1961), this Court said that:

> "The guiding principle of just compensation is reimbursement to the owner for the property interest taken. 'He is entitled to be put in as good a position pecuniarily as if his property had not been taken. He must be made whole but is not entitled to more.' *Olson* v. *United States*, 292 U.S. 246, 255. In many cases this principle can readily be served by the ascertainment of fair market value—'what a willing buyer would pay in cash to a willing seller.' *United States* v. *Miller*, 317 U.S. 369, 374. See *United States* v. *Commodities Corp.*, 339 U.S. 121, 123; *United States* v. *Cors*, 337 U.S. 325, 333."

The Court of Claims patently did not apply the above-cited principles in rendering its paltry judgment. The finding by the Court below as to "just compensation" is analogous to currently valuing the enormously rich Mesabi Range iron ore deposits in Minnesota of the major United States steel companies at the price those companies originally paid for that land. By completely disregarding the precepts of just compensation as enunciated by this Court, the

Court of Claims has committed the grievous error, shocking to the conscience of our society, of confiscating petitioner's precious property, which is entitled to the same safeguards as life and liberty. "When society acts to deprive one of its members of his life, liberty or *property*, it takes its most awesome steps." (*Coppedge* v. *United States*, 269 U.S. 438, 449 (1962); emphasis added). Furthermore, the decision of the court below overlooks the fundamental purpose of "just compensation" as expressed by this Court:

> "The Fifth Amendment's guarantee that private property shall not be taken for a public use without just compensation was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole." *Armstrong* v. *United States*, 364 U.S. 40, 49 (1960).

The federal courts, which follow the teaching of *Mitchell* and *VEPCO*, will apply standards of valuation of just compensation for a taking which, because of the decision below, will vary greatly from the standards applied by the Court of Claims. Such a conflict between courts on a fundamental constitutional guarantee is inconsistent with a uniform administration of justice and should not bar petitioner from receiving just compensation.

The decision of the court below with respect to the evaluation of petitioner's mineral deposits is also in conflict with a prior decision of that court. (*Pashley* v. *United States*, 140 Ct. Cls. 535, 156 F. Supp. 737 (1957)). The Court of Claims correctly stated in *Pashley* that to arrive at the value of land for its highest and best use, that is, as a source of supply of

a mineral deposit, "it is necessary to consider the quantity of material * * * its composition, and its merchantability" (Fdg. 50), which criteria the court obviously ignored in awarding petitioner the trifling sum of $30,000. Here, while attempting to use its crude (1952-58), petitioner incurred a cost increase of $437,879.32, as a result of the soaking of its deposits, which deposits the Court below holds to be worth but the insignificant sum of $30,000.00. (Fdg. 62).

Evidence, conforming to the relevant criteria, to establish "just compensation" for the taking of petitioner's deposits, was adduced by three disinterested witnesses on behalf of petitioner, but was totally disregarded by the Court below.[1]

Fred O. Jones, an eminent consulting geologist who had previously testified on behalf of the United States with respect to the value of mineral deposits (Plaintiff's Exhibit 15), valued petitioner's diatomite reserves taken by the government at $4,580,976. (Fdg. 108, as amended by Appendix C hereto).

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[1] The Court has made findings with respect to the evaluations by two of petitioner's experts: Fred O. Jones (Fdg. 108, as amended by Appendix C hereto); and C. A. Frankenhoff (Fdg. 109), but did not take such findings into consideration in arriving at its judgment. Although requested, the Court did not render findings with respect to the evaluations by Charles E. Wilson (Tr. 1438-1450) and Clark S. Teitsworth (Tr. 1502-1519), petitioner's other evaluation experts. See Plaintiff's Requested Findings of Fact 216-223, filed January 25, 1960; Exceptions and Brief for Plaintiff, filed August 18, 1961, pp. 2-3, 39-47; Plaintiff's Reply Brief, filed January 30, 1962, pp. 77-82; Plaintiff's Motion for Reconsideration, filed June 13, 1962; Plaintiff's Supplemental Memorandum in Support of Its Motion for Reconsideration, filed June 21, 1962; Plaintiff's Reply to Defendant's Motion for Reconsideration, filed July 9, 1962.

Charles E. Wilson, former President of General Electric Company, Executive Vice President of the War Production Board, Defense Mobilizer, head of the Chemical Department and later Chairman of the Board of W. R. Grace & Company (Tr. 1438-1440), testified that he had made a thorough analysis of petitioner's holdings in 1954 when he was considering purchasing same for W. R. Grace & Company (Tr. 1442). However, when petitioner's president advised him of the wetting problem, Mr. Wilson stated that his "interests cooled". (Tr. 1443). As a willing buyer, Mr. Wilson valued petitioner's diatomite deposits taken by the United States at $7,500,000. (Tr. 1446)

Clark S. Teitsworth, Senior Vice President and a Director of Socony Mobil Oil Company, for many years actively participated in the development of the modern diatomite industry, during which time a number of patents in this field were issued to him. (Tr. 1502-1504). Mr. Teitsworth testified that the value of petitioner's diatomite deposits taken by the United States was conservatively $4,500,000. (Tr. 1509-1510, 1519).

In addition to its actual sales of $2,594,550.43, the Court of Claims found that if petitioner's crude had not been wetted, petitioner would have produced and sold from December, 1952, to June 30, 1958, an additional 44,828 tons of finished diatomite products at a net additional revenue of $1,055,059.83. (Fdg. 63). Further, "Plaintiff's president and founder, Mr. C. A. Frankenhoff, a graduate mechanical engineer with many years of training and successful experience in the mining and processing of diatomaceous earth, and sale of diatomite products" (Fdg. 31), "testified that the profit plaintiff would have realized on the mining,

processing, and sale of finished natural products of the amount of 1,563,080 tons, the extent of plaintiff's crude reserves stated in finding 56, would have been about $15,000,000 before taxes and percentage depletion." (Fdg. 109).

CONCLUSION

The action of the Court of Claims in restricting petitioner's recovery for the taking of its valuable mineral deposits to the price paid to farmers and other non-producers for undeveloped and unproven diatomite lands has denied petitioner just compensation under the Fifth Amendment. For all of the foregoing reasons, this petition for a writ of certiorari should be granted.

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December 31, 1962

APPENDIX A

In the United States Court of Claims

No. 298-58

(Decided June 6, 1962)

KENITE CORPORATION v. THE UNITED STATES

Irving G. McCann for the plaintiff. *Ralph E. Becker* and *Malvern J. Sheffield, Jr.*, were on the brief.

Howard O. Sigmond, with whom was *Assistant Attorney General Ramsey Clark*, for the defendant.

OPINION

JONES, *Chief Judge*, delivered the opinion of the court:

Plaintiff Kenite Corporation was organized in 1948 to acquire a diatomite processing plant and diatomite deposits in Grant County, Washington [1] On August 24, 1948, plaintiff purchased 520 acres in fee simple from Dia-cousti-lite Products Company, Incorporated. Through subsequent transactions, plaintiff, by the fall of 1957, owned approximately 735 acres in fee and leased an additional 320 acres—*in toto* an estimated 1,563,080 tons of diatomite reserves.

In this action plaintiff sues for just compensation for the taking of these diatomaceous earth deposits by the invasion of water from defendant's Columbia Basin Project.

Finished diatomite products are used extensively in various commercial enterprises, viz., filter aids, fillers, absorbents, brighteners, carriers, and insulating products. Plaintiff processed crude diatomite obtained directly from its section 20 quarry [2] and from certain stockpiles during the period

[1] See findings 16 through 28 for the geological history and topography of the area involved.

[2] See findings 4, 5, and 28, in particular, for the location of plaintiff's deposits.

October 5, 1948, to December 1952, without experiencing any difficulties in its plant operations attributable to excessive moisture in the crude. However, production difficulties began in early 1953.

It is not economically feasible to process crude diatomite with a moisture content of 50 percent or more. The record in this case, as indicated by extensive findings of fact by the commissioner and which we adopt, clearly shows that the moisture content of plaintiff's deposits did not exceed 25 percent prior to the construction and operation of the Columbia Basin Project. It further shows that such moisture thereafter increased until, by the fall of 1957, the deposits averaged over 50 percent in moisture content.

The Columbia Basin Project was constructed to provide for storage and delivery of water for land reclamation, electric energy and flood control. A major facility is the Grand Coulee Equalizing Reservoir, a body of water 70 feet deep, 27 miles long, and from 1 to 5 miles wide, which extends in a southerly direction, commencing 2 or 3 miles from the site of Grand Coulee Dam. The Reservoir was filled with water by August 1951, and its surface elevation has varied from 1,550 to 1,570 feet m.s.l. since that time.

Plaintiff's lands are located on Babcock Ridge at surface elevations of about 1,350 feet m.s.l. The distances from the south dam of the Equalizing Reservoir to plaintiff's deposits vary from 44 to 52 airline miles in a southwesterly direction.

It is contended by plaintiff that leakage of water from the Equalizing Reservoir into deep aquifers (zones of permeable basalt) raised the piezometric water surface in the area of plaintiff's lands to the extent that the diatomaceous earth deposits were saturated by capillary action.[3] Defendant keeps records of the quantity of water pumped into and released from the Equalizing Reservoir. Records of both input and output are accurate within 2 or 3 percent. Any difference between water pumped in and that released from the Reservoir is attributed to either evaporation or deep

[3] See findings 103 through 106 for a detailed discussion of this theory as advanced by plaintiff's expert witness, Dr. Ruth Terzaghi. Plaintiff's original theory, see finding 7, was satisfactorily rebutted by defendant.

percolation. The latter falls within the 2 or 3 percent margin of error. Thus, water loss from deep percolation could possibly amount to as much as 6 percent of the water passing through the Equalizing Reservoir.

The commissioner has found as not supported by the evidence two arguments of defendant in explanation of the increased moisture: one, that the high moisture content had always existed in plaintiff's deposits due to entrapment of water therein by the last lava flow after exposure to ancient lakes; second, that the increase was caused by natural precipitation into plaintiff's open-pit operations. We accept these findings.

As we stated in *Pashley* v. *United States*, 140 Ct. Cl. 535, 538 (1957), defendant's liability in this type case "depends not on its want of care, but on the fact of taking as the natural consequence of [its] * * * acts." Considering the record as a whole, it is reasonable to conclude that the natural consequence of defendant's activities in connection with the Columbia Basin Project resulted in a raising of the piezometric surface of water located beneath plaintiff's diatomite deposits to such an extent that the moisture content of the crude was so increased as to make it uneconomical to process the crude into finished products.[4]

It is difficult to accurately measure the damages which have been caused to plaintiff's land. But, from the testimony as a whole, we have arrived at $30,000 as the amount which will compensate plaintiff for the decrease in the fair market value of its land—both that held in fee and by lease.[5]

Plaintiff is entitled to recover the decrease in the fair market value of its holdings in the amount of $30,000, and judgment will be entered to that effect with interest thereon computed at 4 percent per annum as a part of just compensation from December 1, 1957, until date of payment.

It is so ordered.

DAVIS, *Judge;* DURFEE, *Judge;* and LARAMORE, *Judge,* concur.

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[4] Although, as indicated by finding 101, part of the increased moisture in two of plaintiff's sections of diatomite reserves was caused by waste water escaping from farms and by seepage from the West Canal, we are of the view that the principal cause of plaintiff's difficulties was as explained in our opinion above.

[5] See finding 110 for the market value of nearby diatomite lands during the period in question.

WHITAKER, *Judge*, delivered the following opinion:

I am not persuaded that the piezometric pressure from the Equalizing Reservoir caused the wetting of plaintiff's diatomaceous deposits. Before filling the reservoir, defendant had drilled a number of wells between the reservoir and plaintiff's deposits. These wells extended through 7 or 8 horizons or strata of lava; that is to say, 7 or 8 different flows of lava. These wells were dug to a depth of some 500 feet or so. After the reservoir had been filled, the water rose decreasingly less the farther the well was from the reservoir, and in those farthest removed, three or four miles away, it did not rise substantially. Plaintiff's deposits were 40 to 50 miles away, on an air line. We know, therefore, that any aquifer that may have existed in these 7 or 8 horizons did not carry the water up to plaintiff's deposits.

However, plaintiff's witness, who was a lecturer in Engineering Geology at Harvard University, surmised that there were aquifers in lower levels of the lava flows, which might have been filled with water, and that the pressure from the reservoir *might* have caused this water to rise through supposed faults or fissures in the lava underneath plaintiff's deposits until it came in contact with them. If it did, it would have been forced up through these fissures 400 or 500 feet. She admits that her theory is only speculation. She says it *might* have been the cause of the wetting of the deposits.

But the burden is on plaintiff to prove that the defendant did wet it. Aside from the speculation of this geologist, we have only the fact that the deposit was not wet before the reservoir was filled with water, and it was wet thereafter. But it is significant that there is no record of the water having been forced up so high at any other place in the 40 or 50 miles between the reservoir and the deposits. At no place did the water rise more than 47 feet, as set out in the trial commissioner's finding 104, and at most places it rose less than 10 feet.

I do not think this is sufficient proof to show that defendant was responsible for the wetting, although, I must confess, I can think of no other explanation therefor. Because I am still in doubt about it, I feel constrained to withhold my concurrence.

FINDINGS OF FACT

The court, having considered the evidence, the report of Trial Commissioner Roald A. Hogenson, and the briefs and argument of counsel, makes findings of fact as follows:

1. Plaintiff is a corporation of the State of Washington, having been incorporated under the name of Quincy Corporation on August 21, 1948, and having had its name duly changed to Kenite Corporation on December 14, 1953.

2. Plaintiff was organized to acquire from Dia-cousti-lite Products Company, Inc., Quincy, Washington, a diatomite plant, inventory, and land containing diatomaceous earth deposits, and thereafter engaged in the mining, processing, and sale of diatomaceous earth products.

From October 5, 1948, to June 30, 1958, plaintiff had gross sales of 76,556 tons of diatomite products for $2,594,550.43, itemized for fiscal year periods as follows:

Period	*Tons*	*Gross sales*
10-5-48 to 6-30-49	1238	$25, 842. 90
7-1-49 to 6-30-50	4989	93, 832. 55
7-1-50 to 4-28-51	8170	197, 777. 16
8-1-51 to 6-30-52	6183	176, 666. 36
7-1-52 to 6-30-53	7574	260, 663. 91
7-1-53 to 6-30-54	6090	221, 658. 09
7-1-54 to 6-30-55	8500	290, 838. 04
7-1-55 to 6-30-56	10590	383, 125. 15
7-1-56 to 6-30-57	12509	470, 480. 72
7-1-57 to 6-30-58	10763	473, 665. 55

During the period April 28, 1951, to August 1, 1951, plaintiff's plant was being reconstructed following destruction by fire.

3. By its petition filed July 2, 1958, as amended January 6, 1960, plaintiff claims entitlement to damages for the alleged taking of its property by the claimed invasion of water from defendant's Columbia Basin Project into plaintiff's diatomaceous earth deposits contained in its lands in Grant County, Washington, which lands are described in findings 4, 5 and 6.

4. Plaintiff is and ever since August 24, 1948, has been the owner in fee simple of the following tracts of land in Grant County, Washington:

> The north half of the northwest quarter ($N\frac{1}{2}NW\frac{1}{4}$) the southwest quarter of the northwest quarter ($SW\frac{1}{4}$

NW¼) and the northwest quarter of the northeast quarter (NW¼NE¼) of section 20, T. 18 N., R. 23 E., W.M., containing 160 acres.

The southeast quarter (SE¼) of section 32, T. 18 N., R. 23 E., W.M., excepting therefrom 60' right-of-way conveyed to the State of Washington by deed recorded January 29, 1918, in Book 22 of Deeds, as Auditor's file No. 31994, containing 160 acres.

The south half of the north half (S½N½) of section 9, T. 19 N., R. 23 E., W.M.; the southwest quarter of the northwest quarter (SW¼NW¼) of section 10, T. 19 N., R. 23 E., W.M., containing 200 acres.

These lands were acquired by plaintiff from Dia-cousti-lite for $25,000 or $48.08 per acre for the 520 acres, as part of its purchase of that company's plant and other assets. The total purchase price was $95,000, $35,000 of which was paid in cash and the balance secured by note and a mortgage on the plant and lands.

5. Plaintiff is and ever since November 16, 1956, has been the owner in fee simple of the following tract of land acquired on that date in four separate parcels from various individual grantors:

Beginning at the northeast corner of section 17, T. 18 N., R. 23 E., W.M., running thence due west on the north section line 214 rods, thence due south 160 rods to the half section line, thence due east along said half section line 214 rods to the east section line, thence north along said east section line 160 rods to the place of beginning, containing 214 acres, more or less.

The total purchase price of this tract of land was $3,491.40, or $16.31 per acre.

6. Under date of August 15, 1950, plaintiff as lessee obtained a lease of the following tract of land for a term of 25 years from September 1, 1949, and thereby the right to remove crude diatomite from such land and the obligation to pay the lessors royalties therefor at the rate of 15 cents per ton of finished diatomite products:

The south half (S½) of section 17, T. 18 N., R. 23 E., W.M.

7. Plaintiff's original claim in this case, as shown by its petition, the opening statement of its counsel at the trial, and the testimony first presented by its witnesses, was that

water which escaped from the West Canal and laterals of defendant's Columbia Basin Project invaded and rendered valueless plaintiff's diatomaceous earth deposits.

During the course of the trial, and after defendant had presented the testimony of a soil physicist to the effect that water could not have invaded plaintiff's diatomaceous earth in the pertinent sections 17, 20 and 32, by the wicking or capillary action necessary to raise such water from the lower levels of seepage of water from the West Canal to the higher levels of such diatomite deposits, plaintiff then presented expert testimony to the effect that leakage of water from the Grand Coulee Equalizing Reservoir, a facility of the Columbia Basin Project, into deep aquifers raised the piezometric water surfaces in the area of plaintiff's lands to the extent that plaintiff's diatomaceous earth deposits were wetted, soaked, and saturated by capillary action.

With the leave of this court, plaintiff filed its first amended petition to include the theory of leakage of water from the Equalizing Reservoir, and thereafter claimed that leakage of water both from the reservoir and the canal and laterals had caused the wetting of its deposits.

Defendant claims that the moisture content of the deposits resulted from natural precipitation being trapped in the open pits of plaintiff's operations, or from the excessive use of water by farmers in the irrigation of lands in the area, or from the entrapment of water in the diatomaceous earth deposits by exposure to lakes in ancient times.

8. The Columbia Basin Project is a multipurpose project constructed by defendant under supervision of its Bureau of Reclamation to provide for storage and delivery of water for reclamation of lands, the generation of electric energy, regulation of stream flow and control of floods, and improvement of navigation. Many plans were prepared for the irrigation and other works of the project, all of which were considered by the Bureau before adoption of the final plan.

The major feature of the project is the Grand Coulee Dam on the Columbia River, which raises the water 350 feet above the old riverbed and creates a lake extending east and then north, 151 miles to the Canadian border.

At Grand Coulee Dam a pumping plant lifts water from the lake, having a surface elevation of 1,290 feet m.s.l., into a two-mile feeder canal which empties by gravity flow into the Grand Coulee Equalizing Reservoir, having a surface elevation of 1,570 feet m.s.l.

The Equalizing Reservoir was created by blocking the north and south ends of a prehistoric channel of the Columbia River, known as the Upper Grand Coulee, with two rock-faced earth-filled dams. This body of water is 70 feet deep, 27 miles long, from 1 to 5 miles wide, and extends in a southerly direction, commencing 2 or 3 miles from the site of Grand Coulee Dam.

9. From the South Dam of the Equalizing Reservoir the project water moves by gravity in a southward direction, first in an open cut, then through the Bacon Siphon and Bacon Tunnel into the Trail Lake Basin, from which it drops in a waterfall into Long Lake Reservoir which is about 6 miles long and was created by construction of Long Lake Dam at the south end of an existing lake. The distance between the Equalizing Reservoir and Long Lake Reservoir is 8 miles.

From Long Lake Reservoir, the water is taken by the project's Main Canal, approximately 6 miles in a southwesterly direction, to the Bifurcation Works, where the canal is divided into the East Canal and the West Canal.

10. The East Canal which is 87 miles in total length extends in a southeasterly direction from the Bifurcation Works, passing Moses Lake three miles to the east, and then southerly along the eastern side of the project to the south end near Pasco, Washington.

11. From the Bifurcation Works, the West Canal, which is 104 miles in total length, proceeds around Soap Lake, crossing the Lower Grand Coulee by means of a siphon at the north end of that lake, thence southwesterly and westerly in the northern extremes of the project lands, past the towns of Ephrata and Winchester to Quincy, thence south to the Frenchman Hills, thence east to Low Gap and thence south through the Frenchman Hills Tunnel to an east-west extension in the valley area lying between those hills and the Saddle Mountains.

12. The Columbia Basin Project, except for the Grand Coulee Dam and its lake, is located within the Columbia River's Big Bend area which is circumscribed by the course of the river from the dam westerly, southerly, and southeasterly to the confluence of the Columbia and Snake Rivers at Pasco, Washington. The airline distance from the Grand Coulee Dam to Pasco is about 125 miles.

The north part of the Big Bend area consists of a high plateau through which the Upper and Lower Grand Coulees were cut, and contains none of the lands to be irrigated by the project. The irrigable lands of the project are south of Long Lake Reservoir, Soap Lake, and the Beezley Hills, and extend within the Big Bend area to Pasco, Washington.

The Quincy Basin, in the western part of which plaintiff's lands are located, comprises the north part of the irrigable lands of the project. This basin is bordered on the north by the Beezley Hills, on the west by the Babcock Ridge, adjacent to the precipitous gorge of the Columbia River, on the south by the Frenchman Hills, and on the east by the gently rising terrain of the area of the East Canal.

13. At the south central border of the Quincy Basin, defendant constructed the O'Sullivan Dam as a part of the overall project. This dam created the Potholes Reservoir at the lowest point in the Quincy Basin in the Drumheller Channels and was designed as a catch basin to collect surface drainage, waste water and return flow in the Quincy Basin. The surface elevation of this reservoir is about 1,045 to 1,050 feet m.s.l. While some areas south of the Quincy Basin are supplied with water from the East Canal which bypasses the Potholes Reservoir on higher land to the east, substantial areas to the south receive irrigation water from the Potholes Reservoir through the Potholes Canal system. The valley immediately south of the Quincy Basin and between the Frenchman Hills and the Saddle Mountains is to be furnished water from the West Canal through the Frenchman Hills Tunnel.

14. Originally, the Bureau planned to provide water from the project to irrigate approximately 1,200,000 acres, subsequently reduced to 1,029,000 acres, and these lands were located, 306,000 acres in the northwestern portion of the project

in the Quincy Irrigation District, 354,000 acres in the East Irrigation District in the northeastern portion of the project, and 369,000 acres in the South Irrigation District.

In August 1959, the Bureau was prepared to deliver water to 411,000 acres, and at that time 260,000 acres of irrigated lands were producing crops.

15. Except for the allocation of $1,000,000 of cost to flood control and navigation improvement, the cost of the Columbia Basin Project was reimbursable to defendant from the revenues from sale of water to farmers and sale of electric energy, and reimbursement was contemplated in forty to fifty years.

From October 1, 1941, to June 30, 1958, defendant was credited in the amount of $148,758,680 in the Federal Treasury as income from the sale by the Bonneville Power Administration of power generated by the Columbia Basin Project, $1,124,419 from the sale of water for irrigation purposes, and $625,000 as miscellaneous income derived from sale of power.

16. The Columbia Basin Project, except for the site of the Grand Coulee Dam and its lake, is located on the Columbia Plateau which was formed by numerous successive flows of lava that occurred 15 to 20 million years ago during the Miocene Epoch. These flows covered a large portion of the interior Pacific Northwest in eastern Washington, eastern Oregon, and western Idaho. The flows pushed the Columbia River north and west around the edge of the advancing lava to its present course in the Big Bend.

The thickness of individual flows varied from a few feet to about 200 feet, but generally from 20 to 100 feet. The total depth of the lava flows is not known, but probably the maximum is from 5 to 10 thousand feet, with the depth probably 5 thousand feet in the Quincy Basin. The thickest depth exposed on the project area is 1,800 feet of layers in the walls of the gorge of the Columbia River where it transects the Saddle Mountains with 800-foot exposures in the gorge west of the Quincy Basin.

17. The time between successive lava flows varied from relatively short geologic intervals to substantial periods of time. In the latter instance, there was an accumulation of soil, gravel, or lava ash in many places, though not con-

tinuously over large areas. Such deposits were probably tightly compacted by succeeding flows.

Each lava flow, commonly known as basalt, is usually a dense, relatively impermeable rock in the lower and the middle zones of the layer, whereas the upper portion is vesicular and sometimes scoriaceous and relatively permeable. These upper zones vary in thickness in each layer, generally from a few inches to about 10 feet, and constitute the aquifers in the basalt. Fissures and joints exist between the various basaltic layers, and transmission of water between the various aquifers could and probably does occur.

18. Because of the modification of the lava flows by folding, faulting, and erosion, hereinafter described, it is difficult to identify any one of the flows for long distances in the overall project area, and any of the basalt aquifers could be discontinuous and vary greatly from place to place in its capacity to hold and transmit water.

There are two flows, one immediately on top of the other, being the second and third from the last of the flows, which are feldspar lava flows, readily identified by unique markings. The top of the upper feldspar flow was very uneven, probably due to high viscosity of the molten rock. During the Miocene Epoch, the climate of the plateau was warm and wet. Lakes formed on top of the upper feldspar flow, and one form of life that thrived therein was a microscopic organism called diatoms.

19. Diatomaceous earth deposits consist of great multitudes of microscopic silica skeletons of diatoms which settled to the bottom of the lakes or seas in which they thrived. Composed of numerous hollow cells of varying shapes, diatomaceous earth is highly porous and absorptive, a poor conductor of heat, electricity and sound, and resistant to heat and chemicals. Finished diatomite products are used extensively in various commercial enterprises as filter aids, fillers, absorbents, brighteners, carriers and insulating products.

The depth or thickness of the diatomaceous earth deposits in the general area of plaintiff's above-described lands ranges from a few feet to 40 feet in some instances. Plaintiff's deposits vary in depth from a few feet to a maximum of 20 feet. The wide variance in thickness is ascribed to the un-

evenness of the feldspar flow. The beds are discontinuous in some places. The term "diatomite horizon" is used to refer to the top of the upper feldspar flow, but does not imply that diatomaceous earth is to be found everywhere at that level.

20. During the Miocene Epoch one additional basaltic lava flow, 40 to 50 feet in thickness, occurred over the top of the feldspar flows. This dried up the lakes and sealed in the diatomite. As the molten lava contacted the water and diatomite, opaline or glass rock was sometimes formed and is found at varying places at the top of the diatomite deposits. In some instances the molten lava poured down through the diatomaceous earth, and shafts of opaline deposits are found here and there through the beds.

21. The Pliocene Epoch succeeding the Miocene was relatively uneventful in the Project area, but thereafter, about a million years ago, commenced the Pleistocene Epoch, known as the Ice Age, with heavy precipitation and with formation in Canada, and southward movement therefrom of massive glaciers which supplied the Columbia River with great quantities of melt water.

The mountains just south of Pasco, Washington, rose up and blocked the Columbia River, and there was created a high lake extending throughout and beyond the whole project area toward Spokane, Washington, with a surface elevation at about 1,300 feet m.s.l. This lake existed for hundreds of years until the Columbia River cut through the new mountains southwest of Pasco, Washington, at Umatilla Gap. Extensive sedimentary deposits, known as the Ringold formation, consisting of a series of stratified silts, clay, sand, and gravel, were laid down throughout the lake. At Pasco these deposits are 900 feet in depth. In the western and northwestern parts of the Quincy Basin, the Ringold formation does not exceed 30 to 40 feet in thickness, but progressively thickens toward the east to about 300 feet at the central part of the basin.

22. After this ancient lake had drained, extensive folding and faulting occurred in and about the project area, probably due to the tremendous weight of the lava flows and superimposed Ringold deposits and to structural adjustments in the Cascade Mountains to the west.

Following such adjustments, the northernmost part of the Big Bend area, through which the Upper Grand Coulee was cut, was left as a high plateau with an elevation of about 2,500 feet m.s.l. Immediately to the south was another but lower plateau with a general elevation of about 1,500 feet m.s.l., through which the Lower Grand Coulee and other canyons were later cut. Next to the south was the Quincy Basin with its lower levels at about 1,150 feet m.s.l., bounded on the south by the folding up of the Frenchman Hills. Still farther south a major folding had resulted in the formation of the Saddle Mountains.

23. Thereafter, the Okanogan Glacier moved from the north and blocked the Columbia River from its present course at the site of the Grand Coulee Dam, causing the river to cut across the higher and then the lower plateau areas, gouge out the Upper and Lower Grand Coulees, and form a huge lake in the Quincy Basin. Large quantities of fluvioglacial outwash of sand, gravel, and boulders were added to the preexisting sedimentary deposits in the basin.

24. The formation of the Upper and Lower Grand Coulees was aided by the effect of torrents, cascades, and waterfalls upon a tremendous zone of folded, faulted, and broken rock, several hundred feet in width, known as the Coulee Monocline. This huge monocline extends steeply in depth through the many layers of lava, and longitudinally for many miles, from the Hartline area east of the Upper Grand Coulee, across the coulee under the southern part of Equalizing Reservoir, then along the western side of the Lower Grand Coulee to a location just north of Soap Lake, and then westerly in coincidence with the south slope of the Beezley Hills.

When the Columbia River resumed its present course, Upper Grand Coulee was left as a boxlike canyon open at both ends, with precipitous walls about one thousand feet high on which were exposed some 12 horizontal layers of lava flow, and a relatively flat floor at about elevation 1,500 feet m.s.l. on which were located Tule Lake and several small lakes prior to filling of the Equalizing Reservoir.

The Lower Grand Coulee slopes from north to south at elevations from about 1,200 to 1,100 feet m.s.l., and contains various natural lakes from north to south called Falls Lake, Park Lake, Blue Lake, Lenore Lake and Soap Lake. Sur-

face drainage from this coulee is prevented by a rise of ground known as the Soap Lake anticline, and the most southerly lake, Soap Lake, is markedly saline.

The Coulee Monocline is exposed at Park Lake in the Lower Grand Coulee down to an elevation of 1,100 to 1,130 feet m.s.l.

25. The Quincy Basin, about 600 square miles in area, with an average elevation of 1,150 feet m.s.l. at its lower levels, was formed by a gentle warping of the layers of lava in such a manner that they have a general and gradual rise from the central part outward to the edges of the basin, with some depressions and troughs in the upper basalt surface. With the overlying sedimentary deposits and soil accumulations, which are progressively deeper from the edges to the center of the basin, the Quincy Basin is a shallow dish-shaped structure. Toward the west, the surface elevations rise gradually to maximum elevations of from 1,400 to 1,500 feet m.s.l. on the Babcock Ridge, from which there is a sharp drop into the Columbia River gorge about 800 feet deep.

Plaintiff's lands are located on the Babcock Ridge at surface elevations of about 1,350 feet m.s.l.

The Frenchman Hills to the south rise to maximum elevations generally between 1,700 to 1,800 feet m.s.l. The considerably higher Beezley Hills, being the westerly part of the northern boundary of the Quincy Basin, are characterized on their south slope by a rather sharp rise of the layers of lava which otherwise rise gently through the basin. The Beezley Hills are at the south end of the high plateau west of the Upper and Lower Grand Coulee.

26. The water of the glacial lake in the Quincy Basin rose until it spilled over the edges and created four outlets: (1) The Trinidad gap in the northwest corner of the basin at the west end of the Beezley Hills; (2) the potholes gap, now known as the Columbia River Wasteway, at the west central edge of the basin; (3) the Frenchman Springs gap in the southwest corner of the basin at the west end of the Frenchman Hills; and (4) the Drumheller Channels at the south central edge of the basin at the east end of the Frenchman Hills.

The first three of the above-enumerated outlets were cut through the Babcock Ridge, and each had an eroded scab-

land approach channel in the high levels of the western part of the basin, each of which dropped sharply into a deeply eroded gap to the Columbia River. The fourth outlet cut down more rapidly than the others and in time carried all of the glacial floodwaters and thereafter nearly all of the surface drainage from the basin. The last location was the site of the construction of the O'Sullivan Dam and the Potholes Reservoir. From the Drumheller Channels, the glacial water emptied through the valley south of the Quincy Basin, lying between the Frenchman Hills and the Saddle Mountains, and eroded a deep gap into the Columbia River at the west end of the valley.

27. Over most of the lands in the irrigation districts of the project, there is a fertile sandy soil. In some areas, there are basaltic scablands resulting from erosion, and in others, the surface consists of deposits of sand or gravel. Erosion of the upper lava flow in the vicinity of plaintiff's lands has resulted in the material overlying the diatomaceous earth being rather thin in places, with some natural exposures of crude diatomite existing, whereas in other places in the general area, the thickness of the overburden may be 50 feet.

28. Plaintiff's lands in sections 9 and 10, described in finding 4, are located on the north rim of the Columbia River Wasteway, the second of the above-described outlets of the Quincy Basin glacial lake.

Plaintiff lands in sections 17, 20, and 32, described in findings 4, 5, and 6, border the area of the scabland channels to the Frenchman Springs gap, the third of the above-enumerated outlets of the glacial lake, with the lands in sections 17 and 20 comprising a contiguous tract on the north side of such channels, and the lands in section 32 to the south thereof.

Natural exposures of diatomite deposits existed and do exist along the edge of both the wasteway and the above-mentioned scabland channels.

29. For many years prior to the construction and operation of the Columbia Basin Project, defendant through various of its agencies knew of the existence, quality, and potential commercial value of diatomaceous earth deposits in and about plaintiff's lands in the Quincy Basin; was aware of the actual mining and processing of such materials; understood the nature and physical properties thereof, and the

uses of diatomite products; and was advised that high moisture content in such deposits increases the costs of mining, transporting, and processing of crude diatomite.

30. Prior to plaintiff's purchase from Dia-cousti-lite of the lands described in finding 4, plaintiff conducted no drilling operations to determine the quantity, quality, and moisture content of the diatomaceous earth deposits in such lands. With the exception of the limited investigation in the south half of section 17, described in finding 36, plaintiff did not conduct a drilling investigation on any of the lands involved in this case until it retained a consulting geologist, Mr. Fred O. Jones, in July 1957.

31. Plaintiff's president and founder, Mr. C. A. Frankenhoff, a graduate mechanical engineer with many years of training and successful experience in the mining and processing of diatomaceous earth, and sale of diatomite products, first visited the Dia-cousti-lite plant and lands in 1943 as a result of his receipt of a letter from an agent of Dia-cousti-lite concerning possible sale of such properties to The Dicalite Company. Mr. Frankenhoff was then president of Dicalite, a corporation engaged in the mining and processing of diatomaceous earth deposits at Terrebonne, Oregon, and also on the Palos Verde ranch near Los Angeles, California. In February 1944 when he was temporarily not associated with Dicalite, Mr. Frankenhoff again visited the Dia-cousti-lite properties and endeavored to obtain an option to purchase the plant and assets. Both negotiations failed because Mr. Frankenhoff considered that Dia-cousti-lite's price was excessive. In December 1944, Mr. Frankenhoff again became president of Dicalite after it had been purchased by Great Lakes Carbon Corporation, and he served in that capacity and also as vice-president of the latter company until October 31, 1947.

In both 1943 and 1944 he took samples of crude diatomite from the open-pit operations of Dia-cousti-lite in section 20, and upon testing, found the moisture content to be about 13 and 17 percent. Prior to plaintiff's purchase of the Dia-cousti-lite properties, Mr. Frankenhoff observed and handled exposures of crude diatomite in sections 9 and 10 and concluded that the moisture content was less than 25 percent. No observation of the moisture content of the

diatomaceous earth in section 32 was made by plaintiff prior to purchase of that tract, but in 1950, Mr. Frankenhoff took a sample from an exposure of such deposits and upon test found the moisture content to be less than 25 percent.

32. In its consideration of the purchase of the Dia-cousti-lite lands, plaintiff relied in part on the March 13, 1939, report of a mining engineer, Max Krom, concerning his investigation for Dia-cousti-lite of the section 20 tract described in finding 4.

The Krom report shows that some test pits were excavated through the overburden and the diatomaceous earth drilled with a 2-inch hand auger, that other locations were drilled with a placer drill and dry cores obtained, and that still other sites were drilled by the wet drilling method. Diatomaceous earth was found and measured in 18 test holes on the section 20 tract. The report advised that chemical analyses of typical samples of crude diatomite indicated exceptional purity. It was stated that the moisture content varied an estimated 5 to 20 percent with a possible 8 percent average, but the report contained no explanation as to how that estimate was made or computed. The report contained a computation that in areas of overburden reasonably removable by opencut mining, there were 88,000 tons of commercial diatomaceous earth reserves in the section 20 tract.

33. Plaintiff's plant was and is located in the town of Quincy on land owned by the Great Northern Railroad. Plaintiff holds this land under a five-year lease which may be canceled upon the giving of 30 days' notice. The plant is about 10 miles from plaintiff's tract in sections 9 and 10, about 17 miles from sections 17 and 20, and about 19 miles from section 32.

After purchase of the plant from Dia-cousti-lite, plaintiff in 1948 expended over $4,000 in changing the plant arrangement to facilitate the movement of employees and to increase the efficiency of operations.

34. On October 5, 1948, plaintiff processed crude diatomite through its plant for the first time, and plaintiff then made its first and only material balance test on the plant operations. The function of this plant was to produce so-

called natural products by reducing pieces and lumps of crude diatomite to a fine size suitable for flash drying, remove waste materials, clean and pulverize to commercial standards of purity and fineness, reduce moisture content to from 3 to 5 percent as required by customers' specifications, and automatically fill 50-pound bags with the finished products. These natural powders were sold by plaintiff to chemical companies, paper manufacturers, companies making insulation products, and silver polish manufacturers.

The material balance check was conducted as follows: The net load of the crude in each truck, obtained from the quarry in section 20, was weighed on an accredited truck scale before dumping into the plant feed bin. The weighed crude only was run through the plant, with the waste therefrom deposited in the previously emptied waste bin. The weight of the waste was then determined and added to the weight of the finished products produced from the crude in the test run. This weight, deducted from the total weight of the crude used, showed that the tested crude from section 20 contained 14.7 percent moisture.

35. All of the crude processed in plaintiff's plant from October 5, 1948, to about September 1, 1950, was loaded in trucks at the section 20 quarry and hauled and dumped into the bin or hopper from which the mill is fed by belt conveyor. No stockpiling of crude was done during this period except for a small surge stockpile maintained at the plant for the convenience of the hauling contractor.

In these operations in section 20, plaintiff stripped the overburden by use of a ripper pulled by a caterpillar tractor, and pushed the overburden off the diatomaceous earth into areas where there was no diatomaceous earth or where such earth had previously been removed. The bulldozer was then used to push crude diatomite through a trap into a dump truck standing at a lower level. The trap consisted of a series of parallel bars employed to screen the crude.

After the material balance test of October 5, 1948, no moisture tests were made until July 1949 when plaintiff first employed a technical manager who commenced to make such tests about once every two days for a short period of time by taking samples from the conveyor belt of the crude obtained from section 20. This manager found this crude so

dry that he added some water to the crude on the feed belt to attain higher humidity and better collection of particles in the plant's cyclone.

This test procedure, thereafter followed by plaintiff to the extent hereinafter described, was to grab by hand crushed crude from the feed belt until a two-pound sample was obtained. After mixing this sample, 100 grams thereof were placed in a pan and heated in an oven at about 212 degrees Fahrenheit for about 1.5 to 2 hours, until there was no further decrease in its weight. Then the dried crude in the pan was weighed, the weight of the pan being excluded in all stages of the test. If this dried sample weighed 80 grams, the moisture content of the crude would be recorded as 20 percent. This method of computation is a determination of the percentage of moisture content of crude on the wet-weight basis usually employed in the industry.

36. After a superficial investigation of the land in the south half of section 17, the tract previously described in finding 6, plaintiff obtained the lease to carry on quarry operations thereon. This tract immediately adjoined plaintiff's section 20 tract on the north.

Plaintiff transferred its stripping and quarrying operations from section 20 to this leased land because Dia-coustilite had carried on such operations in section 20 in such a manner that plaintiff could not be sure without a drilling program where there was crude and where overburden had been dumped after removal of crude.

In March 1950 Mr. Frankenhoff caused overburden to be removed by a bulldozer from diatomaceous earth deposits near a natural exposure in the south half of section 17. He then supervised and participated in the drilling of the diatomaceous earth exposed in the bulldozer cuts by use of an auger to thicknesses as much as 13 feet. From samples taken foot by foot, he concluded that such crude diatomite was of high quality suitable for production of calcined as well as natural products, and that the crude moisture content varied from 13 to 17 percent in the crude taken from the auger holes.

37. About September 1, 1950, plaintiff discontinued all operations in section 20, and soon thereafter commenced the hauling of crude mined from the leased land in section 17.

Stripping and mining in this part of section 17 had been proceeding since about July 1, 1950, and two small temporary stockpiles of crude diatomite which had been built at the new quarry were then removed to the Great Northern stockpiles hereinafter mentioned. After the transfer of the operations, crude was handled in the south half of section 17 in the same manner as it had been in section 20, with deliveries being made to the Great Northern stockpiles.

In 1950, plaintiff endeavored to purchase or lease from four members of a family the land in the north half of section 17, described in finding 5, the purpose being to permit plaintiff to extend its quarry operations in the south half to the north to and beyond the east-west center line of section 17. The owners refused to lease or sell, and plaintiff did not purchase the north-half tract until the owners offered to sell in 1956. Plaintiff made no effort by drilling or otherwise to determine the existence or extent of diatomaceous earth deposits on the tract in the north half of section 17 but purchased said tract in reliance upon the judgment of Mr. Frankenhoff that such deposits extended from the south half into the north half of the section in a large body.

38. At about the time of the commencement of hauling from the section 17 quarry, plaintiff was forced to abandon the surge stockpile at its plant due to dust complaints from the community of Quincy, and thereupon began to build, and by some time in the period between the destruction of its plant by fire on April 28, 1951, and June 1951, had created two stockpiles of crude diatomite, together amounting to sufficient material to produce from 10,000 to 12,000 tons of finished products. These stockpiles were located on land leased from the Great Northern Railroad about one-half mile from Quincy and consisted entirely of crude mined and hauled from the south half of section 17. From June 1951 until the latter part of 1952, plaintiff did no mining and its plant was supplied exclusively with crude from these stockpiles.

When the Great Northern stockpiles were nearly exhausted, plaintiff about December 1952 recommenced mining and hauling of crude from the south half of section 17 to the Great Northern site. About March 1953, to minimize rehandling, plaintiff arranged to have the hauling contractor

dump loads of crude into the plant bin whenever a signal light was displayed at the plant, but otherwise to continue the stockpiling.

In the early part of 1954 plaintiff was required to discontinue stockpiling on the Great Northern site because the railroad desired to use the land for storage of sugar beets and had the right to recover possession of the land on 30 days' notice. For a few months in 1954, plaintiff again maintained a surge stockpile near its plant but again was required to discontinue this practice because of dust complaints. Plaintiff thereafter from late 1954 to 1958 stockpiled in its quarries as described hereinafter.

39. In the spring of 1949 plaintiff purchased a rotary kiln which had been located at Kittitas, Washington, and used there for drying diatomaceous earth. This kiln was installed in plaintiff's plant in parallel with the drying furnace used to make natural products, and was thereafter used by plaintiff to produce calcined and flux calcined diatomite products which were in demand commercially because better suited for filtration purposes than natural products.

Only two companies were producing such calcined products, and the market for them was such that greater profits were realized from their production and sale, although more technical expertness and skill were required in processing.

Plaintiff's previous experience in its quarry operations in section 20 and the drill tests conducted by Mr. Frankenhoff in the south half of section 17, as related in finding 36, indicated that the top and bottom strata of those deposits were of a quality suitable for calcining.

40. When plaintiff's plant was destroyed by fire on April 28, 1951, plaintiff's financial condition was such that it had more than sufficient cash to pay its current obligations and complete the stockpiling program on the Great Northern site. It had reduced its original mortgage liability of $60,000 by payment of about $18,000.

Just prior to the fire, plaintiff had attained a plant-operating time of two shifts per day, five days per week, or 44 shifts per month, and its practice theretofore had been to add shifts as rapidly as expansion of its business justified.

41. Plaintiff's president testified in this case that based on the rate of progress of production and sales to the date of

the fire on April 28, 1951, as shown in finding 2, plaintiff had planned and expected to promote sales and increase its production to the extent of a yearly rate of 17,500 tons of finished products by June 30, 1952. This projection was based on the assumptions that the moisture content of the crude would be 25 percent or less, that plaintiff would continue to produce its finished products at least at its experienced rate of 33 tons per 8-hour shift, that a yearly production rate of 17,500 tons would on that basis require an average of 44 shifts per month, or 2 shifts per day for 22 working days per month, and that there would be the necessary growth of sales.

The expected yearly production of 17,500 tons would have required an average of 1,458 tons per month. Plaintiff's prior production, as computed from the schedule in finding 2, averaged 137 tons per month for the period ended June 30, 1949; 412 tons per month for the fiscal year ended June 30, 1950; and thereafter 817 tons per month to April 28, 1951.

42. Plaintiff's plant was reconstructed and placed in operation by August 1951 producing at first natural powders with later addition of the necessary equipment and production of calcined products. Being unable to produce and deliver its products during plant reconstruction, plaintiff experienced an abrupt loss of its customers who purchased elsewhere, and plaintiff had to begin all over to rebuild sales and confidence. Plaintiff never regained all of the business of one major customer which had previously exclusively placed its orders with plaintiff but which thereafter preferred to maintain business relations with more than one source of supply. During the period from August 1, 1951, to June 30, 1952, plaintiff's production and sales averaged 560 tons per month, or a total of 6,183 tons.

Plaintiff's president testified that in spite of the fire, plaintiff by June 30, 1954, would have increased its production and sales to 17,500 tons of finished diatomite products except for the high moisture content experienced in its crude deposits.

43. From October 5, 1948, to December 1952, plaintiff's plant processed crude diatomite obtained either directly from the section 20 quarry or from the Great Northern stockpiles built from the crude mined and hauled from the quarry in the south half of section 17, as related in findings 35, 37, and 38.

During this period of time plaintiff experienced no difficulties in its plant operations, indicative of high moisture content of crude diatomite. During this same period plaintiff made few moisture tests with substantial intervals between tests. The tests made showed that the average moisture content of the mill feed was 21.7 percent, varying from 13 to 25 percent.

44. By early 1953 plaintiff began to experience reduced production in its plant, which Mr. Frankenhoff at first supposed was due to either carelessness of the mining and hauling contractor in including excessive waste materials in crude, or to inefficiency of the plant manager. In March 1953, when the hauling contractor, otherwise engaged in stockpiling at the Great Northern site, commenced at signal light to dump directly into the plant's hopper loads of crude hauled from the quarry in the south half of section 17, plaintiff immediately experienced trouble in its plant operations and detected that the moisture content of the crude was higher. Plaintiff then installed a double loop in its single-stage drying system.

45. Mr. Frankenhoff first suspected that water from the Columbia Basin Project was invading plaintiff's diatomaceous earth deposits when a representative of the Fish and Game Department of the State of Washington contacted him in August 1953 concerning leasing of plaintiff's tract in sections 9 and 10 for a wildlife preserve on the expressed assumption that such tract would become so wet from the operation of the irrigation project that wildlife would flourish there.

Mr. Frankenhoff and this State wildlife representative thereafter went to the Ephrata, Washington, office of the Columbia Basin Project and discussed with project officials the possibility of exchanging plaintiff's lands in sections 9 and 10 for diatomite land of the Bureau of Reclamation away from that area. Plaintiff requested the Bureau officials to take steps to protect the diatomaceous earth in sections 9 and 10 from wetting, and also asked the Bureau to conduct an investigation of the problem.

46. On or about August 27, 1953, W. E. Walcott, Project Geologist of the Columbia Basin Project, accompanied Mr. Frankenhoff on an inspection of plaintiff's lands.

Mr. Walcott then orally advised Mr. Frankenhoff that in time plaintiff's diatomaceous earth deposits in sections 9 and 10 would become wet from percolated or seeped irrigation waters applied to land by farmers immediately north and above such tracts. Irrigation waters were first introduced into the project laterals and applied by the farmers in this irrigation block in 1954.

Mr. Walcott also advised Mr. Frankenhoff orally that plaintiff's deposits in sections 17, 20 and 32 would not be soaked, but the next day telephoned and stated that in time they would be.

By letter dated November 19, 1953, Mr. Walcott reconfirmed his oral advice to Mr. Frankenhoff concerning wetting of plaintiff's deposits, and with respect to those in sections 17, 20 and 32 further explained that it was planned to irrigate above and adjacent to those tracts in 1957 or 1958 and that such diatomite deposits in due time would probably be affected by percolating or seeped waters from farm irrigation. The project water was first introduced into the laterals in irrigation blocks containing these sections and applied by farmers to their lands in 1958.

47. On or about August 28, 1953, after receiving the telephone call from Mr. Walcott, Mr. Frankenhoff conferred with an official of the project, and suggested that the Bureau cut a ditch around plaintiff's land to isolate the crude deposits from the surrounding area, or that the Bureau remove the overburden and place the crude on top of the land, allowing the plaintiff to reimburse the Bureau as the crude was processed. This official rejected such suggestions, stated that he did not believe that the crude deposits in sections 17, 20, and 32 would be wetted, and advised in effect that the Bureau would take no action on the problem.

Later in 1953, Mr. Frankenhoff conferred with the defendant's Commissioner of the Bureau of Reclamation at Washington, D.C., and was advised to continue to contact the officials of the project at Ephrata, Washington. Mr. Frankenhoff again communicated with Bureau officials at Ephrata and also Boise, Idaho, and no Bureau action was taken.

48. After Mr. Frankenhoff's contacts with the State wildlife representative and defendant's project geologist, plaintiff conducted daily moisture tests of the mill feed at its

plant. This crude was from the quarry in the south half of section 17, and was supplied to the plant in part by direct hauling from the quarry and otherwise from the Great Northern stockpiles. The average moisture content shown by these tests from late August through December of 1953 was 40.3 percent. There had been no moisture tests on crude from December 1952 to August 1953.

This high moisture content reduced plaintiff's production, and plaintiff thereafter made many plant changes to cope with the problems. In February 1954 plaintiff installed a double-drying system in an effort to regain its previously experienced production rate of four tons of finished products per operating hour.

49. From late 1954 through most of 1958 plaintiff supplied its plant with crude from stockpiles which were maintained in its quarries in sufficient quantity to meet the plant's requirements for 2 to 4 months of operation. These stockpiles were turned over in an attempt to reduce the moisture content.

During 1954 and 1955 the moisture content of the mill feed averaged respectively 43.5 and 45.9 percent, this crude having been obtained entirely from the quarry in the south half of section 17. The crude was hauled directly to the plant from these quarry stockpiles during 1954 and 1955, except for the 1954 hauling operations previously mentioned in finding 38.

50. Plaintiff endeavored to find drier crude for its plant. About August 1955 it leased from the Bureau of Reclamation the northeast quarter of section 32, being a tract of land immediately north of plaintiff's section 32 land described in finding 4. Plaintiff thereafter proceeded to remove overburden and commence quarry operations on this leased tract.

During 1956 about 75 percent of the mill feed came from the section 17 quarry and 25 percent from section 32. The moisture content of the mill feed from section 17 averaged 46.7 percent during the first two months, and 36.7 percent for the balance of the year. The average moisture content of the section 32 mill feed was 50 percent for the year.

51. In July 1956 plaintiff by use of a bulldozer cut trenches and found two new areas of diatomaceous earth deposits in its section 20 tract and thereafter opened quarry operations designated as pits 20–1 and 20–2.

During 1957 about 70 percent of the mill feed came from the section 17 quarry, 20 percent from pits 20–1 and 20–2, and 10 percent from section 32, with the moisture content of the mill feed from these sections averaging for the year respectively 42, 24.5, and 52.3 percent.

52. In July 1957 plaintiff retained Mr. Fred O. Jones, a private consulting geologist, for the following express purposes: (1) To make a geological study of the area in which the diatomaceous earth deposits, owned or leased by the Kenite Corporation, were located in the Quincy Basin area of Grant County, Washington; (2) to determine what effect the geology of the area had, and would continue to have, on water lost from the Columbia River Basin Project in the Quincy Basin; (3) to make tests of the moisture content of the diatomaceous earth deposits owned and leased by the Kenite Corporation in the Quincy Basin, and to determine to what extent Kenite's crude was wet, and the amount and value of crude ruined by such wetting; (4) to determine the cause of the increased moisture in Kenite's diatomaceous earth deposits; and (5) to put down test holes elsewhere, to attempt to discover new sources of crude that were dry enough to mine and process profitably, if the tests on Kenite's property established that its deposits were so soaked as to render the mining and processing of this crude commercially unprofitable.

53. Mr. Jones is a graduate geologist with extensive practical experience in the Pacific Northwest both as a private consultant and as a professional employee of the United States. From February 1940 to January 1947 he served as Project Geologist, Columbia Basin Project, the project involved in this case, and from June 1948 to July 1955 as a planning and research geologist, Engineering Geology Branch, United States Geological Survey, in the Pacific Northwest. He was well acquainted with the geological literature on the project area, including unpublished Government reports, some of which he had prepared.

54. Following general field examinations and studies of geologic structures in the area, Mr. Jones personally supervised in the fall of 1957 the drilling of a total of 144 test holes on plaintiff's lands described in findings 4, 5, and 6, such drillings being distributed 25 holes on the two section 17

tracts, 103 on the section 20 tract, 8 on the section 32 tract, 5 on section 9, and 3 on section 10.

In addition to the drilling on plaintiff's lands, Mr. Jones, in an effort to find drier crude deposits, supervised in the fall of 1957 the drilling of 10 test holes on section 16 and 9 holes on section 18, these sections being adjacent respectively on the east and west to the pertinent section 17.

In March 1959 Mr. Jones in a successful effort to find drier crudes, conducted the drilling of 72 test holes in section 8, T.17N., R.24E, W.M., located immediately south of the Quincy Basin, high on the south slope of the Frenchman Hills at about elevation 1510 feet m.s.l., where the moisture content of the diatomaceous earth deposits was found to vary from 7 to 25 percent with an average of 18 percent. There had been no irrigation on the south slopes of the Frenchman Hills, and the geologic structure was not favorable for movement of ground water into these section 8 deposits from those areas of the project being irrigated. These section 8 deposits are located from 5 to 9 miles from plaintiff's lands in sections 17, 20 and 32.

55. From his studies of the general geology and the topography of the lands, Mr. Jones determined the places at which he would drill test holes. The general pattern of drilling was on 300- to 900-foot centers in grid pattern, except that in areas where crude was found sufficiently dry to be mined and processed, as described in the last paragraph of finding 54 and in finding 57, drilling was on 100-foot centers.

In each test hole in which diatomaceous earth was encountered, samples thereof were placed in sealed jars and the moisture content thereof determined at plaintiff's plant by testing in the manner that mill feed had been tested as previously stated in finding 35.

56. In his 1957 drilling operations, Mr. Jones observed and recorded the thickness and nature of the overburden, the extent of glass rock waste, and the thickness and quality of the diatomaceous earth. From the data thus obtained and from his observations otherwise, Mr. Jones then mapped out on plaintiff's lands areas of diatomaceous earth reserves reasonably minable except for moisture content. He then computed the volume of diatomaceous earth in tons on a dry-weight basis by taking the average thickness as shown by the

drillings, extending the same over the reserve area, with elimination of glass rock waste as estimated from his data, and with the use of the accepted standard of 25 pounds of dry diatomaceous earth per cubic foot.

In such reserve areas, all located on plaintiff's lands described in findings 4, 5, and 6, Mr. Jones found diatomaceous earth reserves in quantity in dry tons in the tracts in the respective sections, with moisture content averages, as follows:

Location	Dry tons	Average moisture content
		Percent
North half of section 17	927,736	53.6
South half of section 17	434,579	53.6
Section 20	77,285	43.6
Section 32	71,401	52
Section 9	19,827	50
Section 10	32,252	52
Total dry tons	1,563,080	

Mr. Jones found from his 1957 investigations that the average moisture of all of these diatomaceous earth reserves was above 50 percent with some tests showing as much as 65 percent.

Approximately 850 acre-feet, or 1.15 million tons of water would be required to increase the moisture content of 1.54 million tons of crude from 20 percent to 50 percent, and about twice that much to increase the moisture content of the same amount of crude to 66 percent.

57. The exploration program conducted by Mr. Jones in 1957 revealed three quarry areas in section 20, which areas were designated as pits 20–2 extension, 20–3 and 20–4, where the crude was considered sufficiently dry for economical operation by plaintiff. These three areas totaled 7.77 acres and contained an estimated 33,450 tons (dry-weight basis) of diatomaceous earth, with an average moisture content of 24 percent. This tonnage was not included by Mr. Jones in his computations shown in finding 56.

58. In the fall of 1958, plaintiff advised Mr. Jones that it was experiencing higher moisture content in the crude from pit 20–4 than was expected from the 1957 drill records. In December 1958, Mr. Jones obtained a series of diatomaceous earth samples from pit 20–4 by digging about three feet into

the north face of that pit at three levels at each of five stations designated as J–1 to J–5, taking a sample from each level at each station. These stations were located each a short distance from 1 or 2 of the 1957 test holes. Moisture content tests were made of these J–1 to J–5 samples and compared with the moisture content found in the nearby test holes in 1957.

The following table shows the average moisture content in October 1957 of the crude taken from the pertinent 1957 test holes, the average moisture content of the samples taken in December 1958 from each of the nearby stations of the J series, and the increase in moisture content of the crude as shown by comparison of the results of the 1957 and 1958 tests, expressed both in actual increase and percentage of increase:

October 1957	December 1958	Actual increase	Percentage of increase
	Percent	*Percent*	*Percent*
29.5 percent (holes 64 and 67)	35.2 (J–1)	5.7	19
34.5 percent (holes 58 and 65)	45 (J–2)	10.5	30
31 percent (hole 50)	39 (J–3)	8	26
32.5 percent (holes 13 and 45)	45 (J–4)	12.5	38
26.5 percent (holes 36 and 43)	29.9 (J–5)	3.4	13

In July 1959 Mr. Jones repeated his tests at the J–1 to J–5 stations and found average moisture content of the samples at each station to be respectively 29.7, 44, 35.5, 38.2 and 29.4 percent.

The average moisture content of the crude taken from all of the above-enumerated 1957 test holes was 30.8 percent, the average of all of the tests of the J series holes being 38.8 percent in 1958 and 35.4 percent in 1959. From all of these tests, Mr. Jones concluded that there had been a definite rise in the moisture content of diatomaceous earth deposits in this area between 1957 and 1959, ascribing the fact that the moisture content in the July 1959 tests was somewhat less than the December 1958 tests to be due to drying of the surface of the north face of pit 20–4 by summer heat and wind.

59. The Krom report, previously mentioned in finding 32, showed that 5 of the 18 test holes in that 1939 investigation of plaintiff's land in section 20 were located within that part of the tract in which Mr. Jones found and mapped his sec-

tion 20 crude reserve area, previously described in finding 56. In contrast to Krom's low estimate of moisture content in these crude deposits, Mr. Jones found an average moisture content of 43.6 percent in 1957.

The average thickness of these crude deposits as reported in Krom's logs of the five test holes was shown to be 13.3 feet, whereas Mr. Jones computed the average thickness of these reserve deposits to be 10.6 feet after elimination of glass rock waste.

60. As the moisture content of crude deposits increases, the cost of transportation of the crude rises markedly. If the crude moisture is 15 percent, 390 pounds of water are transported in the 3.8 cubic yards of crude required to produce one ton of finished products; if 25 percent, 730 pounds of water; if 50 percent, 2,200 pounds of water; and if 60 percent, 3,500 pounds of water. Because of the porous nature of the crude, the volume in cubic yardage of crude necessary to produce one ton of finished products is not increased by absorption of water. However, the increased weight requires the trucker to reduce the cubic yardage hauled per load to stay within the load limit of the truck. Thus, a truck with a capacity of 29.4 cubic yards of 15 percent moisture crude would be limited to haulage of 17.5 cubic yards of 50 percent moisture crude.

61. Higher moisture content of the crude progressively reduces the plant production rate and increases the fuel, power, labor and other costs of production per finished ton of products.

Plaintiff's plant has the maximum capacity to evaporate 2,300 pounds of water per operating hour and still maintain a production rate of 4 tons of finished products per hour. During the period from October 1948 to December 1952, plaintiff's plant did maintain such an hourly production rate whenever in operation. The few moisture tests of mill feed during that period indicate that the moisture content varied between 13 and 25 percent, and plaintiff's plant during that time was on that basis evaporating water from the mill feed to the extent of 1,664 to 1,885 pounds of water per hour.

During the period from August 1953 to June 1958, the moisture tests of mill feed taken from the quarry in the south half of section 17 show that throughout that period

plaintiff's plant would have been required to evaporate an average of 5,050 pounds of water per hour from such mill feed in order to maintain a production rate of 4 tons of finished products per hour, but such water content would reduce the production rate of the plant in the use of section 17 crude to 1.6 tons per hour. These latter figures comprehend the use of mill feed, the moisture content of which was somewhat reduced by turning over the quarry stockpiles. The moisture content of the section 17 crude, as found by Mr. Jones, would require without turning of stockpiles, evaporation of 8,720 pounds per hour to produce 4 tons of finished products per hour, which would reduce the production rate to nearly one ton per hour.

62. From December 1952 to June 30, 1958, plaintiff incurred total increased costs of operations in the sum of $473,879.32, as a result of the higher moisture content experienced in its crude deposits. The categories of increased costs included labor and supervision, loading and hauling, fuel, power, and repairs and maintenance.

Plaintiff's fuel and power costs were $2.528 per ton of finished products from October 1948 to June 30, 1950; $2.392 per finished ton from July 1, 1950 to November 30, 1952; and $4.88 per finished ton from December 1, 1952 to June 30, 1958.

63. Plaintiff produced and sold 52,872 tons of finished products at an average selling price of $37.80 per ton during the period December 1952 to June 30, 1958. Plaintiff's president testified that if higher moisture content of crude had not been experienced, plaintiff would have during the same period produced and sold at the rate of 17,500 tons of finished products per year, or a total of 97,700 tons or 44,828 tons more than was actually produced and sold.

On the basis that the lost tonnage of 44,828 tons would have been sold at the average selling price of $37.80 per ton, plaintiff claims its total loss of revenues in that period of time was $1,694,498.40. From this total plaintiff deducts as additional costs, which would have been necessary to produce the 44,828 lost tons, the sum of $639,438.57, leaving a claimed net loss of revenues of $1,055,059.83.

To the last figure, plaintiff adds its total increased costs of operations of $473,879.32, stated in finding 62, to arrive

at its total "losses attributable to increase in moisture" for the period December 1952 to June 30, 1958, in the sum of $1,528,939.15.

64. After the completion of Mr. Jones' original investigation in December 1957, plaintiff limited its stripping operations exclusively to the areas in section 20 designated as 20–2 extension, 20–3, and 20–4, previously described in finding 57. From October 1, 1958, to September 30, 1959, plaintiff's plant processed only crude from these areas, with the moisture content averaging 30.3 percent, and with the fuel and power costs being $2.20 per finished ton. Plaintiff's plant production rate was 4 tons per hour during this period.

65. Although plaintiff did no stripping operations in the south half of section 17 or in the northeast quarter of section 32 after December 1957, it had stockpiles of crude remaining in both quarries.

In May 1958 plaintiff constructed an auxiliary bin at its plant for use in mixing crude, suitable for production of calcined and flux calcined products obtained from the stockpiles in sections 17 and 32, with similar crude obtained from pits 20–2 extension, 20–3 and 20–4. Because plaintiff's kiln capacity for producing calcined and flux calcined products had been lower than its ability to produce natural materials, plaintiff in April or May 1958 installed a dual plant system of "constant production" designed to permit production at the same rate whether entirely natural products or partly calcined and flux calcined products.

Because of the high moisture content of the mill feed resulting from the mixture of the wetter crude from sections 17 and 32 with the crude from pits 20–2 extension, 20–3 and 20–4, plaintiff was forced to reduce the feed of this mixed crude into the dual system to the extent that profitable production of calcined and flux calcined products was impossible. Plaintiff then attempted to use only the above mentioned section 20 crude which failed to produce flux calcined products sufficiently white to meet specifications. Since flux calcined products constituted 90 to 95 percent of its sales of calcined materials, plaintiff discontinued production of calcined products on or about September 24, 1958, notified its customers accordingly, and filled existing orders by purchases from competitors.

Prior to September 24, 1958, calcined and flux calcined products represented from 30 to 40 percent of the tons of finished products sold by plaintiff, but about 50 percent of its total revenues from sales. The gross profit on them was 40 percent, contrasted with 20 percent on natural products.

66. The total annual production of all diatomite products in the United States was by 1958 about 450,000 tons per year. Plaintiff was in third place as a producer of calcined products.

67. A diatomite plant designed and constructed to process crude with a moisture content of 50 percent or more, would be valueless as a commercial enterprise because it could not compete with other plants in the industry.

68. From 1927 until 1932 extensive investigations concerning development of the entire Columbia River system, including among other projects the proposed construction and operation of the power and irrigation works of the Columbia Basin Project, were conducted by the Army Corps of Engineers pursuant to authorization contained in the River and Harbor Act approved January 21, 1927. The official report of the Chief of Engineers, dated March 29, 1932, copy of which was submitted to the Commissioner of the Bureau of Reclamation, was published in 1933 as House Document No. 103, 73d Congress, 1st Session.

With respect to the part of the report concerning the Columbia Basin Project, the Commissioner of the Bureau of Reclamation advised the Chief of Engineers, by letter dated March 19, 1932, that there was complete agreement between the engineers of the War Department and those of the Bureau regarding the plans which should be adopted for irrigation and power development.

The Army Engineers' report showed that they had conducted extensive geological and hydrological investigations of the Columbia Basin Project area, considered the suitability of the Upper Grand Coulee as a reservoir site and the probable extent of leakage of water therefrom and proposed general plans and layout of the overall project and analyzed problems concerned with its construction and operation.

69. Contained in the Army Engineers' report was a report, dated January 7, 1932, from the Chief Engineer of the Bureau of Reclamation to his Commissioner concerning the

proposed Columbia Basin Project. This report was based upon a review of a comprehensive report, with maps, plans, and calculations, submitted by the Corps of Engineers, as well as other investigations of the proposed project by the State of Washington, the Bureau of Reclamation, and the United States Geological Survey, dating as far back as 1904.

This Bureau report stated the walls of the proposed reservoir in the Upper Grand Coulee, now known as the Equalizing Reservoir, were composed largely of basalt, that the walls below the flow line were generally covered with unconsolidated talus slopes of sands, gravels and silt, with some exposures of basalt; and that the floor of the site consisted mainly of unconsolidated silts, sands, and gravels overlying basalt, with exposures of basalt near the south end and some granite near the north end. Concerning leakage from the Equalizing Reservoir, this report states as follows:

> All of the geologists who reported on this reservoir agree that the most likely place for serious leakage to occur is at the southern end of the reservoir site, where a steep monoclinal fold [Coulee Monocline] occurs in the basalt. The inclined flows and the more permeable contacts between the successive flows along which water could percolate are exposed in the sides and bottom of the coulee. There is some disagreement as to the extent of such leakage; Cooper and Jenkins believe that the sharp folding of the basalt was accompanied by faulting along which water could readily escape; Williams believes that, while no general faulting occurred, the folding caused some fractures in the adjacent basalt; Bryan, Landes and Ransome recognize the possibility of leakage along the inclined contacts between the flows and apparently believe that such fractures as may be accompanied by the folding are superficial or will be sealed by the silt which covers the bed of the reservoir.
>
> Ransome and Bryan believe that an underground hydraulic gradient exists from the plateaus toward the reservoir basin so that the pressure thus created would prevent the movement of water from the reservoir toward the sides. Mr. Williams, on the other hand, believes that a general hydraulic gradient exists from the east to west, so that while the raising of the water level would not be sufficient to reverse the gradient to the east, it would cause a steeper gradient to the west. He states that seepage along the west side of the reservoir would be limited by the permeability of the wall; in this

connection he points out the possibility of fractures existing, especially at the southern end near the monoclinal fold.

All of the geologists contemplated a maximum flow line elevation of 1,552.5 feet in the reservoir, while present plans contemplate a maximum flow line elevation of 1,570 feet.

In view of the impossibility of determining in advance the extent of the reservoir leakage, such leakage has been very conservatively estimated as 1,000 second-feet (corresponding to about 1-inch loss per day) for the purposes of this report.

70. The Army Engineers' report showed that the above-mentioned estimate of water loss from the reservoir of 1,000 second-feet, representing over an inch a day, or 31.2 feet a year, covered both leakage and evaporation, and that all experts consulted considered such estimate to be conservatively high. The existence of the aquifers in the basalt was recognized, and it was noted that the possibility of seepage through the contact planes of successive layers was a source of "grave concern" as to the feasibility of the reservoir site. One reporting geologist advised that leakage from the reservoir would be of the slow but persistent type, in an amount difficult to calculate in advance, that the great basaltic basin to the south, covering many hundreds of square miles, was capable of storing an enormous volume of water, and that leakage from the reservoir would be at such depth that probably no indication of it would appear anywhere at the surface, certainly not for a long space of time.

The investigating geologists, however, were in general agreement that the proposed reservoir site would not develop any substantial leakage, that the area of the greatest danger was where the Coulee Monocline crosses the coulee, and that this area should be excluded from the proposed reservoir. Accordingly, the Army Engineers decided to locate and planned the construction of the south dam across the coulee at a location north of the Coulee Monocline, and reported that the elimination of the monoclinal area from the reservoir, the various geological reports justified the conclusion that any loss by leakage of water would not be exorbitant.

71. The Army Engineers recommended and planned concrete lining of all canals and laterals leading to the individ-

ual farm units in the project area, stating that the increased cost would be more than justified by the saving effected in reduction of the canal section due to higher permissible velocities, and to the reduction in seepage loss from the system. The probable loss of water by seepage and evaporation from the concrete-lined system was estimated by the Army Engineers to be 2 percent in the main canal and 6 percent in the distributing system.

72. The Army Engineers reported that lands within the project area were strictly arid in character, the rainfall varying from 6.6 inches in the west to 12 inches in the north and east. Ownership of irrigable lands in the project area was stated to be 5.5 percent by the defendant, 5.3 percent by the Great Northern Railway, 4 percent by the State of Washington, and 85.2 percent by private owners.

73. Prior to the construction of the Columbia Basin Project, defendant had been advised in various official reports of the United States Geological Survey and the Bureau of Reclamation that there would be heavy losses of water in the project area from irrigation and from unlined portions of the canals and distribution systems, and that a dangerously high water table would develop unless these water accretions were disposed of through natural underdrainage, or unless artificial drainage measures were provided.

Defendant was further advised in such reports that about 25 percent of water entering unlined canals and laterals is lost by seepage before it reaches the fields to be irrigated, that seeped water frequently collects in lower lands, making them unproductive or necessitating expensive drainage systems, and that seepage water from a canal often travels surprising distances and may emerge adjacent to the canal far from where it escaped, or may sink through underlying strata and escape through natural drainage channels.

74. Defendant was further advised in such reports that as a result of the operation of the subject project, there would be a pronounced rise in the ground water table throughout the Quincy Basin, and that in the Babcock Ridge area the water table would rise considerably and stabilize at a probable depth "of a few tens of feet" below the surface.

Defendant was further advised that some of the water lost from the irrigation project would be blocked by impervious

basalt or caliche layers from descending to the water table, and that such water would either surface in lakes or ponds, or become underground water perched above the water table on irregularities in the basalt layers.

75. Defendant was further advised that seepage losses from the canal system and from irrigation of lands would cause damage to some private property in the project area, and that the rise of the water table would be sufficient to make an adequate drainage system a necessity. No adequate drainage system has been developed on the project lands.

76. The south dam of the Equalizing Reservoir was constructed under the direction of the Bureau at a location which included the Coulee Monocline within the reservoir site. This monocline crosses the reservoir floor from a point along the east wall *about 4 miles north* of the south dam and leaves the reservoir on the west side about a mile north of the right or west abutment of the south dam. The Equalizing Reservoir was filled with water by the Bureau by August 1951, and since that time its surface elevation has varied from 1,550 to 1,570 feet m.s.l.

77. Prior to the construction and filling of the Equalizing Reservoir, the Bureau conducted extensive investigations concerning possible leakage or loss of water therefrom. One of such investigations concerned whether there would be losses through the sides of the reservoir.

In 1945 water levels were measured in existing wells in the high plateau areas on both sides of the Upper Grand Coulee to determine natural water levels in those areas. Water elevations in the plateau on the west side were found to exist from 1,877 to 2,056 feet m.s.l., and on the east side from 1,689 to 2,342 feet m.s.l., substantially above the proposed and later accomplished surface elevation of the Equalizing Reservoir. From these investigations, the Bureau concluded that there would be no lateral loss of water from the reservoir. Realizing the possibility of escape of water from higher to lower aquifers, the Bureau estimated that about 19,000 acre-feet might seep from the reservoir through deep aquifers into Moses Coulee (tributary to the Columbia River) about 20 miles to the west of the reservoir site, but no such water has ever appeared there.

78. The Bureau also conducted extensive diamond drilling investigations, with more than 150 holes being drilled within four square miles at, above, and below the site of the south dam prior to construction. About 40 holes were drilled at intervals along the axis of the south dam. The drilling program was generally to a depth of six horizons, being numbered in order of depth, first the upper part or aquifer of the highest basalt flow, then the aquifer part of each of the two feldspar flows, then in succession the aquifer portion of the next three underlying basalt flows. As the drilling progressed from horizon to horizon, the bit was withdrawn and water was pumped into each hole under pressure to determine what the loss of water would be in each horizon. This was accomplished by use of multiple packers and separate pipes to seal off and test one aquifer separately from the others within one drill hole. As many as eight test pipes were used in one hole, since eight horizons were tested in four holes and seven horizons in four or five others. The Bureau found that there was substantial variation in the permeability of the horizons or aquifers within one drill hole and of each horizon from one drill hole to another.

79. After the filling of the Equalizing Reservoir, the Bureau continued to make observations of the water levels and pressures in the various horizons in the test holes previously drilled below the south dam. These tests were made at two-week intervals up to and including 1954, and at two-month intervals thereafter. In the test holes immediately south of the dam, the water levels rose substantially, and this rise was generally less as the distance between the dam and the test hole increased.

The movement of water through an aquifer requires force, or head, exerted at a higher altitude, the energy of which is consumed as the water moves, with permeability of the aquifer being an important factor. The force or pressure on such water which would cause it to rise like artesian water at any point in the aquifer is known as piezometric pressure, and the level to which water rises from an aquifer in a drill hole or well is called the piezometric surface.

By testing the drill holes at various intervals south of the dam site, the Bureau in effect observed the extent of the loss of water from the reservoir into the upper six aquifers and

to a limited degree in the seventh and eighth horizons. The drop in gradient or drop in the level of the water in the test holes varied somewhat from north to south. However, the elevation of the water in the test hole drilled at the center of the dam was observed and compared with the elevation of the water in the test hole drilled 1.5 miles south of the center of the dam. It was observed that the loss in the elevation of the water in the distance between the test holes was different in each horizon. In horizon 2 there was a loss in the elevation of the water of 9.8 feet between the two test holes, whereas the loss was 153.7 feet in the 5th and 6th horizons.

Similar tests were made in the various horizons in test holes on an axis extending south from the east end of the dam, and also on such an axis from the west end. On the east axis, the loss of the elevation of the water within 1.5 miles varied from 61.7 feet in horizon 4 to 151.8 feet in horizon 6. On the west axis, the loss in elevation within the same distance was .3 foot in horizon 1 and 33.8 feet in horizon 4.

From these tests the Bureau concluded that the hydrostatic pressure resulting from the filling of the Equalizing Reservoir was dissipated in the tested horizons to minute amounts within a relatively short distance.

80. The Bureau anticipated that there might be a theoretical loss of about 1,300 acre-feet per year of water from the Equalizing Reservoir to the Lower Grand Coulee. Horizons 1 to 4 are and were exposed in the Dry Falls area, horizon 5 in the High Hills anticline, horizon 6 in the Soap Lake anticline, and probably horizons 7 and 8 in the bed of Lake Lenore, all of which exposures are within or in the area of the Lower Grand Coulee. Although repeated tests and observations have been made and the levels of various lakes checked, the Bureau has never been able to detect any loss of water from the reservoir into the Lower Grand Coulee.

81. The Bureau keeps a record of the quantity of water pumped into the Equalizing Reservoir, and the quantity released therefrom. The degree of accuracy of hydraulic measurements is such that the records of both input and output are accurate within 2 or 3 percent. The Bureau also keeps a daily record of the surface elevation of the reservoir. The estimated evaporation rate from the surface of the

reservoir is about 64 to 68 inches per year, with variations from year to year.

The difference between the water pumped into the reservoir and that released therefrom is attributed to loss either by evaporation or deep percolation. The approximate loss of water from the reservoir by evaporation amounts to 125,000 acre-feet per year, and the Bureau concludes from its records that deep percolation losses from the reservoir fall within the 2 or 3 percent margin of error in measuring the input and output of reservoir water.

82. By use of the permeability tests conducted by the Bureau, as stated in finding 78, the Chief, Ground Water Engineering Branch, Bureau of Reclamation, computed that horizons 1 to 8 immediately below the south dam would take water under the hydrostatic pressure of the filled reservoir at the average rate of 1,300 acre-feet per year. The highest permeability shown in such tests was at the rate of 2,100 to 2,600 acre-feet per year. With the highest permeability shown, the seepage velocity of the water through the pertinent aquifers would be 1.98 to 2.5 feet per year. On this basis, it would require 70 years for water to travel through these aquifers from the reservoir to Soap Lake at the south end of the Upper Grand Coulee.

Soap Lake is located about 17 airline miles from the south dam, whereas plaintiff's lands in suit vary in distance from 44 to 52 airline miles from the south dam.

83. The Bureau anticipated that the Coulee Monocline might be open at great depths and might permit considerable leakage from the reservoir. No effort was made to grout this huge geological structure. The Bureau drilled a total of 12 test holes on both sides of the Coulee Monocline in the area just north of the west or right abutment of the south dam, prior to construction, and concluded from the water level measurements therein that the flow or gradient of water was from the area above and along the monocline into the reservoir site. Since the construction of the reservoir, no water has seeped or escaped from the Coulee Monocline where it is exposed down to elevations of 1,100 to 1,130 feet m.s.l. at Park Lake in the Lower Grand Coulee.

84. The Ankeny Shaft is located on the floor of the Equalizing Reservoir about two miles upstream from the south

dam. It was apparently formed by the action of waterfalls in the erosion of the Upper Grand Coulee, and consists of an area across the coulee filled with boulders and coarse material to great depth, with large open spaces. Pumping tests on drill holes in the Ankeny Shaft at or near the Coulee Monocline showed permeability hundreds of times greater than the results of the tests at and below the south dam.

85. The part of the West Canal (its entire course being described in finding 11) which extends in the Quincy Basin from Ephrata westerly to Quincy and then south to the Frenchman Hills was constructed at a lower elevation than the plan proposed by the Army Engineers in House Document 103, 73d Congress, 1st session. This location was chosen to avoid difficult construction and maintenance problems and to obviate building expensive siphons through the Columbia River Wasteway and the Frenchman Hills gap, previously described in finding 26. To supply irrigation water to irrigation block 73, north of this relocated part of the West Canal, and to blocks 74, 77, and 79, west thereof, the Bureau planned and constructed pumping stations to lift the water from the canal into laterals on these higher lands.

86. The Bureau's "Standard Specifications for Construction of Canal Systems, March 1949", embodying basic specifications formulated to cover usual conditions, typical features, and normal procedures involved in construction of canal systems, stated that concrete lining or pneumatically applied mortar lining shall be constructed in the canal prism where shown on the drawings.

The West Canal was lined with concrete from the Bifurcation Works to a point approximately seven or eight miles east of Quincy, and concrete lining was not used below that point in the West Canal or its laterals. The special provisions, specifications, and drawings, covering construction of the unlined part of the West Canal, stated that such canal sections would not be lined with concrete, earth or gravel blanket, and that references to linings in the otherwise applicable provisions of the "Standard Specifications for Construction of Canal Systems, March 1949," should be disregarded.

87. Prior to the construction of the West Canal, the Bureau dug numerous test pits in the land subsequently ex-

cavated to provide the canal course, and prepared logs of the materials encountered. From station 1230 (where the concrete lining ends) to station 1350, the logs of 10 of the 14 test pits showed sand, gravel, cobbles, and boulders. From stations 1350 to 1390, the materials were well cemented or compacted. From 1390 to 1480, the logs of the test pits showed numerous references to sand, gravel and boulders; from 1480 to 1750, near the town of Quincy, relatively tight deposits of silty sand, silt, sand, and caliche; from 1750 to 1800, where the canal proceeds south, considerable amounts of sand, gravel and boulders; and from 1800 to 1975, principally silt and sand. From 1975 to 2044, near the approach channel to the Columbia River Wasteway, the deposits were sand, gravel, and cobbles, and thereafter to station 2084, the canal bottom was excavated in basalt with overlying sand, gravel, and boulders. From 2084 to 2450, the canal was excavated in silty, sandy material, containing much loose sand, gravel, and boulders, as recorded in the logs of 37 of 42 test pits excavated between those stations. From 2450 to 2560, the test pits revealed principally sand, silt, and caliche, somewhat tighter than in the preceding section. From 2560, where the canal course extends easterly along the Frenchman Hills to Low Gap at about station 2840, the materials encountered were generally cemented caliche and compacted silts and sands, with only occasional deposits of loose materials.

88. In 1951 construction of the West Canal had been completed to the Columbia River Wasteway at about station 2044. In that year 22,700 acre-feet of water were released from the Bifurcation Works to test the unlined part of the canal to station 2044, and none of this test water was permitted to go below that station. No irrigation of lands occurred that year. Practically all of that water was lost by seepage from the canal.

On October 5, 1951, the Bureau observed that one large leak had developed in the West Canal at about station 1900, about 3 miles south of Quincy, presumably caused by the presence of a lens of gravel or some other pervious material over which the canal bank fill was placed.

By October 22, 1951, the Bureau noted that between stations 1790 and 1800 there was substantial leakage or seepage

from the West Canal to the extent that the canal water was moving toward a depression about 400 feet to the east and that a pond was forming therein about 2 feet deep and several hundred feet long.

89. In 1952 the Bureau released 197,000 acre-feet of water into the West Canal, and some of this water was used for irrigation of lands near Soap Lake and below the canal in the Quincy-Winchester area, but otherwise for continued testing of the canal.

In that year the so-called fourth section of the West Canal, being that part from station 2044 at the Columbia River Wasteway to the Frenchman Hills tunnel, was tested. There were high losses of water by seepage or leakage from the fourth section during the spring and summer of 1952, with the total of loss to ground water from that section amounting to at least 23,000 acre-feet during that period. Loss of water from the canal above the fourth section continued in spite of repair operations conducted by the Bureau.

By June 2, 1952, the Bureau noted that serious leakage from the West Canal had occurred between stations 2145 and 2450 due to the high permeability of the gravels and sand throughout that section. On July 1, 1952, the Bureau reported that there was "very great" loss between stations 2140 and 2274 of the water introduced during the preceding month into the fourth section, which water was gradually increased to 400 c.f.s. to force the flow toward the Frenchman Hills tunnel. This part of the West Canal is located about 6.5 miles from plaintiff's diatomaceous earth deposits in sections 17 and 20. During July 1952 about 25,000 acre-feet of water were run into the fourth section to test the reach of the canal between the Columbia River Wasteway and the Highway No. 10 bridge across the West Canal, and current meter measurements were made in an effort to pinpoint places of heavy losses.

During the period from May through July 1952 numerous shallow ponds formed on both sides of the canal in the area of high water loss in the fourth section between stations 2145 and 2450. The canal course through this area follows a slight ridge, and seepage ponds formed in this area to the west of the canal within a distance of a quarter to a half mile. Most of the ponds were east of the canal, and there

was a pronounced movement of this water easterly and southeasterly. When the canal was emptied, the ponds dried in sequence from those closest to the canal toward the east and south. Many of these ponds have refilled after commencement of irrigation.

90. During the years 1953 through 1958 the loss of water from the West Canal and its laterals was in acre-feet as follows: 122,000 in 1953; 115,000 in 1954; 164,000 in 1955; 162,000 in 1956; 186,000 in 1957, and 196,000 in 1958, or an accumulated total of 945,000 acre-feet in these years.

During the years 1951 through 1958 the water released from the Bifurcation Works into the West Canal system was in acre-feet as follows: 22,700 in 1951; 197,000 in 1952; 324,000 in 1953; 424,000 in 1954; 540,000 in 1955; 578,000 in 1956; 616,000 in 1957; and 700,000 in 1958; or a total of 3,401,700 acre-feet in these years.

The percentages of water lost from the West Canal and its laterals for each of the years 1953 through 1958 were as follows: 37.6% in 1953; 27.1% in 1954; 30.3% in 1955; 28% in 1956; 30.1% in 1957; and 28% in 1958, or an overall percentage for these years of 30.2%.

Applying the overall percentage of 30 percent to the 197,000 acre-feet released into the West Canal system in 1952, the loss for that year was 59,100 acre-feet, which, added to 22,700 acre-feet lost in 1951, and the 945,000 acre-feet lost in 1953 through 1958, results in an accumulated total loss of 1,026,800 acre-feet in the years 1951 through 1958.

This combined total represents losses due to seepage or leakage from the West Canal and its laterals, evaporation, and operational waste of water.

The evaporation rate from an exposed water surface in the Quincy Basin averages about 67 inches per year.

91. Annual precipitation in the Quincy Basin averages about 8 inches. At Ephrata, Washington, with an altitude of 1,275 feet m.s.l., the lowest annual precipitation in the years 1951 through 1958 was 5.22 inches in 1952, the highest was 12.13 inches in 1951, and the other years varied from a low of 7.07 inches in 1954 to a high of 9.98 inches in 1958. The precipitation at Ephrata is distributed throughout the year, but the summer months have lower precipitation and

the winter months higher than the general monthly average. The highest precipitation in any one winter month during the years 1951 through 1958 was 2.05 inches in January 1953, whereas an occasional summer month had no precipitation or merely a trace thereof.

92. Commencing in June 1953, the Bureau had extensive canal lining and canal repair work performed on the West Canal and its laterals under contract specifications, with the major work on the West Canal being the placing of compacted earth lining in the fourth section between stations 2145 and 2364 where the worst leakage had occurred in testing. Concrete lining was placed in some laterals in irrigation block 77 on the Babcock Ridge, some distance north of plaintiff's tracts in sections 17 and 20, during 1958 and 1959.

93. The ground water table in the alluvial deposits or mantle above the basalt in the Quincy Basin was generally at about elevation 1,080 feet m.s.l. prior to construction and operation of the project, and had been at such elevation for many years prior thereto. These elevations existed in the basin in the areas to the south and east of the present course of the West Canal, whereas in areas immediately to the north and west thereof such elevation was 1,050 feet m.s.l.

During the years 1952 through 1958, the Bureau recorded the rise in the ground water surface elevations in the alluvial deposits in the basin and prepared for each of these years a ground water surface elevation map of the Quincy Basin.

In 1953 the ground water table was highest at 1,250 feet m.s.l. in a small area west of Quincy and north of the West Canal. From this area, the elevation of the ground water table gradually declined toward the east, south, and southeast. The contour of the elevation at 1,200 feet m.s.l. crossed the West Canal about 3 or 4 miles east of Quincy and about 5 or 6 miles south thereof. The 1,150 contour crossed the canal still farther east and south, with the 1,100 contour extended through the central and north central areas of the basin. The southern and southeastern parts of the basin had had very little rise by 1953 in the ground water table.

From the pattern shown in the 1953 map, there was a gradual extension of the rise in the ground water table from the Quincy area to the south, east, and southeast through the years 1954 through 1958 so that the areas within the re-

spective contour lines progressively increased from year to year. In 1954, the area within the 1,200 contour elevation extended well into the area designated as irrigation block 74, west of the West Canal and north of the Columbia River Wasteway, and by 1956, the 1,250 contour elevation was considerably extended into the same area. By 1956, the area within the 1,150 contour was extended somewhat to the west of the canal into irrigation blocks 77 and 79, and by 1957, a two-mile long area on either side of the canal, located east of the approach areas to the Frenchman Springs gap had developed a ground water surface elevation of 1,200 feet m.s.l., and this ground water table surface expanded somewhat in area in 1958.

In 1958, a small area to the northwest of Quincy had a ground water surface elevation of 1,300 feet m.s.l., and the 1,250 contour extended to include some areas to the south and east of the West Canal in the vicinity of Quincy, and extended substantially to the west of the canal in irrigation block 74 and in close proximity to plaintiff's tracts of land in sections 9 and 10. By 1958, the 1,200 contour included a large area of land to the south, east, and southeast of the West Canal, and this contour had crossed the canal to the west and entered the northeastern part of irrigation block 77. The 1,150 and 1,100 contour elevations were by 1958 still farther moved into the central and south central parts of the basin.

94. The general pattern of the commencement of the irrigation of farms in the Quincy Basin from water supplied by the West Canal and its laterals was from north to south from one irrigation block to another. In 1952, irrigation commenced in blocks 70 and 701 located at or near Soap Lake, and seepage therefrom into the lake required a pumping program to protect shoreline properties. In the same year, irrigation commenced in blocks 71 and 72, both being located immediately to the south of the east-west extension of the West Canal in the Quincy-Winchester area and to the east of the southerly course thereof. In 1953, irrigation commenced in block 73 on the higher lands to the north of the east-west extension of the canal.

Irrigation commenced in 1954 in block 74 lying to the west of the West Canal and bordered on the south by the

Columbia River Wasteway, and in which plaintiff's section 9 and 10 tracts are located. In the same year, irrigation commenced in block 75, lying to the east of the canal and south of block 72.

In 1955, irrigation commenced in blocks 76 and 78, lying in succession south of block 75 on the east side of the canal, with block 78 extending to the Frenchman Hills.

In 1956, there was no additional block opened in the West Canal system, but in 1957, irrigation commenced in block 89 in the central part of the basin.

In 1958, irrigation commenced in blocks 77 and 79 lying in succession on the west side of the canal between the Columbia River Wasteway and the Frenchman Hills. Plaintiff's section 17 and 20 tracts are located in block 77, and its tract in section 32 in block 79.

95. From a comparison of its records and resulting maps of the rise of the ground water surface elevations in the alluvial deposits of the Quincy Basin with the information and maps concerning when irrigation commenced in the various blocks, the Bureau concludes that the rise in such water tables resulted from excessive application of water by the farmers to their lands.

Water application to farms by irrigation is measured in terms of acre-feet per acre per year. Whereas, 3.5 to 4 acre-feet per acre would be sufficient to irrigate a crop, the new farmer, partly because of inexperience, will use from that amount up to double the sufficient quantity. From previous experience on other irrigation projects, the Bureau anticipated a repetition of such practices on the subject project. This excessive use of water for irrigation is due in part to the fact that the cost of the water is substantially less than the labor required to exercise sufficient control over its application to the farmlands. The excessive water applied is disposed of by evaporation from the soil, surface runoff, or deep percolation into the ground.

The testing of the lateral system in each block occurred first in the year in which irrigation of farms commenced in such block, and there was coincidence from north to south throughout the West Canal system in the progressive use of the lateral systems and the application of water to farms.

96. From all of the evidence in this case, it is found that

the moisture content of plaintiff's diatomaceous earth deposits did not exceed 25 percent prior to the construction and operation of defendant's Columbia Basin Project, and that thereafter such moisture content increased until by December 1, 1957, the plaintiff's reserves, described in finding 56, had moisture content averaging above 50 percent.

The geological speculation that such high moisture content had always existed in plaintiff's deposits and was due to entrapment of water therein by the last lava flow after exposure to ancient lakes is rejected as contrary to the weight of the evidence with respect to the increase in moisture content of plaintiff's deposits. The claimed contribution to said reserves of any moisture increase by natural precipitation into plaintiff's open-pit operations is not supported by substantial evidence.

97. The opinion of plaintiff's consulting geologist, Mr. Fred O. Jones, as shown by his testimony in this case, was that "part" of the 81,800 acre-feet of water lost from the West Canal and its laterals in 1951 and 1952 traveled southwestward from the area of the worst canal leakage between stations 2145 and 2364 through pervious soils and gravels west of the canal, from which area such water seeped through the earth materials forming the bottom of a scabland approach channel to the Frenchman Hills gap, until such water reached a point at the eastern edge of section 16, where such water contacted diatomaceous earth deposits, that such water was perched on impervious basalt and rose by wicking action through such deposits into plaintiff's deposits of diatomaceous earth in the adjoining sections 17 and 20, and that such movement of water resulted in the increase in moisture observed by plaintiff in such deposits by December 1952, within about 15 months after its first escape from the canal.

By September 1959, three seep lakes with a total area of 4 or 5 acres with depths of 10 to 15 feet and surface elevations at 1,173 to 1,176 feet had formed in a scabland channel and a diatomaceous pit excavation in section 22 about 1.5 to 2 miles to the east of plaintiff's section 20 tract and about 3 miles west of the West Canal. These were formed from seepage water from the West Canal.

98. The area of canal leakage between stations 2145 and 2364 is located 6.5 miles northeast of plaintiff's tracts in

sections 17 and 20. The elevation of the bottom of the canal in that area is 1,207 feet m.s.l. Mr. Jones conceded that more of the water seeping from the canal would move to the east than to the west. The bottom of plaintiff's diatomaceous earth deposits in sections 17 and 20 is at about elevation 1,330 feet m.s.l. From his drilling operations in section 16 in 1957, previously mentioned in finding 54, Mr. Jones reasonably concluded that the diatomaceous earth deposits continued from plaintiff's section 17 tracts and dipped easterly through section 16 to the eastern edge thereof, where they reached approximately the same elevation as the above-mentioned base or bottom of the West Canal. The distance from the eastern edge of section 16 to plaintiff's tracts in sections 17 and 20 is about 7,000 feet, and the difference or rise in elevation was from 125 to 150 feet between the lower level where the diatomaceous earth horizon in the eastern part of section 16 could come into contact with any of such canal seepage water and the higher level of the bottom of plaintiff's deposits in sections 17 and 20.

99. The theory that water could move through diatomaceous earth deposits by wicking or capillary action for a distance of 7,000 feet with a rise in altitude of from 125 to 150 feet within 45 months was refuted by the testimony of Dr. Walter H. Gardner, a soil physicist on the faculty of the Washington State College. Dr. Gardner had obtained representative samples of diatomaceous earth, consisting of large blocks, from plaintiff's quarries. The blocks were cut into five smaller blocks ranging from 3 or 4 inches in width and depth to about 2 feet in length. These blocks were first tested to determine the rate of vertical rise of water by capillary action by standing them on screens in pans of water. Horizontal and vertically downward movement through the blocks was also tested by using wicks to supply water to the end of each block, with the block extended horizontally or vertically downward. The tests were each run with the moisture content of the block previously adjusted and with the block containing different percentages of moisture, first at about 8 percent, then about 18.5 percent, and then about 22 percent.

In the tests on the vertical rise and the horizontal and downward movement of the water through the blocks by

capillary action, observations were made and recorded of the rate of movement, that is, distance as a function of time. The rate of movement was fast through the first inch or two and progressively diminished as time passed. By projecting the rate of diminishment of advance with the extent of passage of time, as shown by his tests on the sample blocks, Dr. Gardner concluded and testified that it would require 10 years for free water (not under pressure) to move between a minimum of 15 to a maximum of 150 feet through diatomaceous earth deposits like the samples he tested. He further concluded that such capillary movement of free water in diatomaceous earth is somewhat more rapid downward than upward, with horizontal movement at a rate between the other two, but that the rates as to all three are within the same order of magnitude.

100. The opinion of Mr. Jones was that "part" of the accumulated total of 1,026,800 acre-feet of water lost from the West Canal and its laterals in the years 1951 through 1958 has continued to soak plaintiff's diatomaceous earth deposits in sections 9, 10, 17, 20, and 32, and that with the continued buildup in the ground water table and further extension of perched water tables, all of such deposits will reach a complete saturation point of 65 percent, and will remain in that condition as long as the Columbia Basin Project is in operation.

Mr. Jones concluded that the rising ground water table and perched water in the areas of plaintiff's deposits had resulted from the operation of the Columbia Basin Project, had been responsible for the increased moisture content of such deposits, and that wicking action had progressively saturated the deposits. His observation of data concerning a well dug through diatomaceous earth to a depth of 50.6 feet at the northeast corner of plaintiff's section 17 tract caused him to conclude that in 1957 the ground water table in [redacted] area was about 1,150 feet m.s.l. as compared to the lower elevation of 1,008 feet m.s.l. for that area, found by the United States Geological Survey for 1949. With respect to plaintiff's diatomaceous earth deposits in section 32, he gave no direct testimony as to the rise in the water table in that area, but indicated on the map of a geologic cross-section of the land between section 32 and the West

Canal 6.6 miles to the east, that in the vicinity of the canal the water table had risen to about 1,150 feet m.s.l. in 1957 from an elevation of 1,080 in 1948. No explanation is given as to how wicking action could have caused the increased moisture content of the section 32 crude, and there is no substantial evidence that the diatomaceous earth deposits, obviously discontinuous to the north, extended easterly to the vicinity of the West Canal.

101. By 1957, the ground water table throughout most of block 74 (in which are located plaintiff's section 9 and 10 tracts) had risen to 1,250 feet m.s.l. from a pre-project level of 1,050 feet m.s.l. In 1957, there was a high level lake, perched above the ground water table, adjacent to plaintiff's crude reserve area in section 9. Mr. Jones saw and observed this lake and noted that water being wasted from higher farmlands was running into that lake in 1957. By 1959, three or four other small lakes had formed in the same area.

It is reasonable to conclude that the increased moisture content of plaintiff's crude reserves in sections 9 and 10 was caused in part by waste water escaping from farms and also in part by seepage from the necessarily higher laterals of the West Canal in block 74. However, such causes cannot be ascribed to the increased moisture content of plaintiff's deposits in sections 17, 20, and 32 because irrigation water was not introduced into defendant's distributing system nor applied to any farms in blocks 77 and 79 until 1958, almost a year after Mr. Jones' investigations established the high moisture content. Furthermore, blocks 77 and 79 are isolated from areas to the north by the Columbia River Wasteway and at the east by the West Canal, and seepage from laterals or farm units outside of blocks 77 and 79 could not affect sections 17, 20, and 32, except by adding to the general water table of the entire basin.

102. Dr. Gardner also conducted desorption tests on small samples of plaintiff's diatomaceous earth, obtained from each of the five quarries of the plaintiff, to determine its water retention properties and the distance that would have to exist between such diatomaceous earth of a given moisture content and a free water table, that is, to place an upper limit on the moisture content of a diatomaceous earth bed at a

certain elevation above a free water source, with the moisture content derived by capillary action. The test procedure was that a sample was placed on a porous membrane suspended in a container to the bottom of which was attached a tube capable of holding a hanging column of water at a given distance below the sample but not in contact therewith, with open air space existing between the water surface and the membrane. The tube was flexible which readily permitted raising and lowering of the water surface and thereby decreasing or increasing the distance between the sample and the water. Dependent upon the distance between the sample and the water surface, the hanging column of water has the effect of drawing water from a relatively wet sample into the porous membrane, whereas a relatively dry sample will absorb water therefrom. If the moisture content of a sample has become stabilized by keeping the distance constant, the moisture content can then be increased by raising and decreased by lowering the water level, allowing time in each instance for the physical action to take place. Various samples were tested in this manner, and the stabilized moisture content at varying distances observed and recorded as to each. From the data obtained as to stabilized moisture content at varying distances, a desorption curve for each set of samples from each quarry was plotted on graph paper. On the basis of this generally accepted test procedure, Dr. Gardner concluded and testified that it was "extremely unlikely" that the claimed increased water content of plaintiff's diatomaceous earth deposits could have been caused by capillary action from a free water source or free water table even as high as 1,200 feet m.s.l.

According to Dr. Gardner's desorption curves, diatomaceous earth beds having a stabilized moisture content between 23 and 27 percent would be 340 feet above the free water table; between 27 and 33 percent, 280 feet above; between 30 and 37.5 percent, 240 feet above; between 33 and 41 percent, 200 feet above; between 37.5 and 47.4 percent, 160 feet above; between 42 and 53 percent, 120 feet above; between 44.5 and 56.5 percent, 100 feet above; between 47.4 and 58.5 percent, 80 feet above; between 50 and 61.5 percent, 60 feet above; between 53 and 63.5 percent, 40 feet above; between

56.5 and 65 percent, 20 feet above; and between 60 and 68 percent, 10 feet above to zero elevation.

The above recited figures assume that the moisture content has become stabilized or is in equilibrium, by the passage of sufficient time for completion of the capillary action. They are further based on the assumption that the rise of water is from free water not under force or piezometric pressure. Once water under piezometric pressure has risen through fissures or into a drill hole to a piezometric surface, or the highest level which can result from the pressure, such surface becomes a free water surface which may be above or below the ground water table in the alluvial deposits.

103. Dr. Ruth D. Terzaghi, lecturer in Engineering Geology at Harvard University, was plaintiff's expert witness on the theory that seepage of water from the Equalizing Reservoir into basaltic aquifers had raised piezometric pressure to the extent that water rose into contact with plaintiff's diatomaceous earth deposits which were then wetted by capillary action.

To determine the estimated piezometric surface elevations of ground water in the vicinity of plaintiff's deposits in sections 17 and 20, Dr. Terzaghi used data gathered from the logs of 19 drill holes, some of which had been dug in the investigation conducted by Washington State College in 1958, and others in 1957 by Mr. Jones. By considering the average of the moisture content found in samples taken from each hole, correlated with the data concerning elevations, and by applying the results of the desorption curve tests of Dr. Gardner, Dr. Terzaghi inferred and concluded that the estimated piezometric surface of water from aquifers underlying or in the vicinity of plaintiff's tracts in sections 17 and 20, varied between 1,247 and 1,323 feet m.s.l., with the piezometric surface being at the base of the deposits at elevations 1,291 to 1,323 feet m.s.l. in the 5 holes considered in section 17, and with the distance between the base of the crude deposit and the estimated piezometric surface varying between zero and 50 feet in the 19 holes. In the 5 drill holes in section 17 the diatomaceous earth was too wet to sample at the base of the deposits.

Actually water was not encountered in some of the 19 test holes even though dug to elevations below Dr. Terzaghi's

estimated piezometric surface. Her explanation was that in such cases the water-bearing portion of the aquifer had not been penetrated by the drill hole, or that a local sealing of the aquifer existed at that point.

Dr. Terzaghi's analysis showed that in the general area of sections 17 and 20 the estimated piezometric water surface sloped generally from the north to the southeast, south and west, from higher to lower piezometric levels, and her conclusion was that the source of the water causing the new high piezometric surfaces was from the north.

104. Dr. Terzaghi explained the wide variation of from 15 percent to 65 percent moisture content of samples taken from various drill holes on the basis that the process of wetting the diatomaceous deposits was not yet complete and that there was a lack of equilibrium between the new high piezometric surface and diatomite deposits. Her theory was that water rose under piezometric pressure from aquifers underlying the deposits in sections 17 and 20, and by analogy in section 32, through fissures or clay-filled joints into the diatomite beds and spread in all directions through the deposits, and the lack of equilibrium in the deposits was indicative that the process had commenced in the recent past and had not been of ancient origin. She also testified that the highest piezometric elevation recorded prior to 1952 for wells in basalt in the southwestern part of the Quincy Basin was from 1,008 to 1,068 feet m.s.l., and in contrast to the relatively rapid rise of the ground water table in the alluvial deposits, the piezometric surfaces in the Quincy Basin rose very slowly from 1952 through 1954, with most of the deep wells in the basalt layers rising less than 10 feet by 1956, but that one such well in the west central part of the Quincy Basin had shown a substantial rise from 1,078 feet m.s.l. in 1952 to 1,125 feet m.s.l. in 1955. The deep wells in aquifers in the northern part of the basin rose rapidly beginning as early as the summer of 1952. She further testified that well records showed that the basaltic aquifers of the Quincy Basin are generally well-sealed from water which seeps from the surface into the mantle or alluvial deposits.

105. Dr. Terzaghi's opinion was that the rise in piezometric surfaces in the Quincy Basin was due to addition of water

to the aquifers where the edges of the lava flows were exposed at an elevation higher than that to which the piezometric surfaces have risen. She stated that such exposures possibly occur on the south slope of the Beezley Hills, where the highest laterals of the West Canal flow above southward dipping beds of basalt at elevations up to 1,500 feet m.s.l., and certainly do occur in the Equalizing Reservoir at elevations about 1,550 feet m.s.l. She stated that the evidence was not conclusive that the added water in the aquifers came from the reservoir, but that two sets of factors suggested strongly that it did: (1) The rise in the deep wells immediately south of irrigation block 73 (the block on the south slope of the Beezley Hills) occurred prior to 1952, or prior to introduction of irrigation water thereon, but after the filling of the Equalizing Reservoir; and (2) the rapid and high rate of rise of the piezometric surfaces in the deep wells in the northern part of the Quincy Basin occurred within the relatively short period of 3 years after commencement of irrigation in that area.

She further testified that well records showed that the deeper aquifers in the Quincy Basin held much more water than the higher ones, but that water from a deep aquifer could under high pressure rise through fissures or joints into a higher one. Some highly productive wells in deep aquifers produce by pumping between 700 and 1,500 gallons per minute. Furthermore, she testified that water entering an aquifer at the Equalizing Reservoir would not have to travel through the aquifer all of the way to plaintiff's diatomaceous earth deposits to effect an increase in moisture content because the added pressure to the water already in the aquifer would be distributed relatively quickly throughout the aquifer.

106. Dr. Terzaghi's opinion was that the increased moisture content in plaintiff's diatomaceous earth deposits could have been caused by water percolating or seeping into deep aquifers exposed in the Equalizing Reservoir or by water moving along or behind the Coulee Monocline to a point in the eastern end of the Beezley Hills, that from either place the added water in the deep aquifers caused a rise in the piezometric surface under plaintiff's diatomaceous earth deposits, and that water rose from the deep aquifers into con-

tact with such deposits and wetted them by capillary action.

Dr. Terzaghi recognized that a watertight barrier seemed to exist to a depth of several hundred feet in the vicinity of the Beezley Hills and to the northeast thereof, which would explain lack of leakage from the Coulee Monocline where it is exposed at Park Lake, but believed that at greater depths such added water could have passed through or under the Coulee Monocline separating the Beezley Hills from the Quincy Basin.

107. The increased moisture content in plaintiff's diatomaceous earth reserves, as stated in finding 56, rendered them economically valueless.

The highest and best use of plaintiff's lands described in findings 4, 5, and 6, was as a source of diatomaceous earth up to the time that plaintiff's crude deposits were wetted and soaked.

108. Plaintiff's consulting geologist, Mr. Fred O. Jones, was a principal witness in behalf of plaintiff concerning evaluation of plaintiff's property allegedly taken by the defendant by construction and operation of its Columbia Basin Project. Although he had done considerable research of reports and literature about other diatomaceous earth deposits and diatomite mining and processing operations, he had not visited any other deposits nor observed any other such operations. He had not had any previous experience as an appraiser of properties. The theory of his evaluation was that the wetting of plaintiff's crude reserves was not just a taking of the pertinent land but was a taking of the entire business of the plaintiff. Accordingly, he requested by letter dated September 16, 1957, to defendant's Bureau of Mines, advice as to the proper method of evaluating minable but unmined diatomite reserves. By letter dated October 3, 1957, a Mr. Otis of that Bureau responded to Mr. Jones, and made suggestions which Mr. Jones followed.

Based upon figures furnished to him by plaintiff from its books and records, which were audited but not challenged by defendant, Mr. Jones was advised that plaintiff's experienced cost of producing one ton of finished diatomite products from crude having a moisture content of from 15 to 20 percent, was $26.00. Because he concluded that stripping costs might be as much as one-third greater in the mining out of

plaintiff's crude reserves, mapped by him as shown in finding 56, he adjusted the $2.00 per finished ton figure for that item upward to $3.00, and allowed $27.00 per ton as the overall cost. The average selling price of plaintiff's products in 1957 was $37.80 per finished ton. Using a production and sales volume of 17,500 finished tons per year, a figure furnished by plaintiff, and a profit rate of $10.80 per finished ton, being the difference between the above-mentioned figures of $37.80 and $27.00, Mr. Jones computed that plaintiff's profit before taxes would be $189,000 per year.

At a production and sales rate of 17,500 tons of finished products per year, Mr. Jones computed that plaintiff's crude reserves of 1,563,080 tons, as shown in finding 56, would be sufficient for 89 years of operation. He then applied present worth tables at 4 percent to the total profit for an operating life of 89 years, at a profit rate of $189,000 per year, and concluded and testified that the present worth value of plaintiff's diatomite reserves of 1,563,080 tons, described in finding 56, was $4,580,976.

Using the same method of evaluation, but restricting the computation to 635,344 tons of crude reserves, that is, the above-mentioned total of 1,563,080 tons less the 927,736 tons in the area of crude reserves in plaintiff's tract in the north half of section 17 (not purchased by plaintiff until 1956, as stated in finding 6) Mr. Jones concluded and testified that on the basis of a 36-year operating life the present worth value of such 635,344 tons of crude reserves was $3,573,665.

109. Plaintiff's president, Mr. C. A. Frankenhoff, also testified concerning evaluation of plaintiff's crude reserves had they not been made economically valueless by increased moisture content. He based his evaluation upon the profit of $11,000, before taxes and percentage depletion, realized by plaintiff on the production and sale of 1,200 tons of finished natural products in September 1959. The crude used during that month was obtained from stockpiles made from the limited areas of dry crude deposits in section 20, and such stockpiles comprised an amount of deposits obtainable from about one-quarter of an acre of land. The rate of plaintiff's plant production during that month was slightly more than 4 tons of finished natural products per operating hour, with the moisture content of the crude on the feed belt

averaging 23.8 percent. The total production of 1,200 tons in September 1959, projected to an annual rate, would amount to 15,000 tons of finished natural products per year.

By simply projecting the profit rate of $11,000 on plaintiff's production and sale of 1,200 tons of finished products in September 1959, Mr. Frankenhoff concluded and testified that the profit plaintiff would have realized on the mining, processing, and sale of finished natural products of the amount of 1,563,080 tons, the extent of plaintiff's crude reserves stated in finding 56, would have been about $15,000,000 before taxes and percentage depletion.

110. Defendant's evaluation witness was Mr. Ezra Erich, a consulting geologist and mining engineer, with extensive experience in the exploration of mineral deposits and preparation of reports on the development thereof. He had never engaged in the mining, milling, or sale of diatomaceous earth products. He had previously qualified and testified as an expert mining engineer, geologist and mineral appraiser in the United States District Court at Sacramento, California, and in several state courts in California. He had previously made appraisals of diatomite deposits in Shasta County, California, in 1952, and at Kittitas, Washington, in 1957. In 1957, he made a general inspection of plaintiff's deposits in the Quincy Basin, and on April 14, 1959, made a complete tour and observation of all of the plaintiff's tracts described in findings 4, 5, and 6. His finding was that plaintiff had paid $67.30 per acre to Dia-cousti-lite for the tracts described in finding 4. In doing so, he was advised that the purchase price for the 520 acres was $35,000 rather than $25,000, accounting for the lesser price of $48.08 per acre stated in finding 4. He correctly learned that plaintiff in 1956 paid $16.31 per acre for the 214-acre tract described in finding 5. He visited the Terrebonne diatomite deposits of Great Lakes Carbon Company near Richmond, Oregon, the Lompoc deposits of Eagle Picher Company in California, and also other deposits of these and other companies in Nevada. In the course of his investigations, he inquired concerning sales of land containing diatomite deposits, and learned that major companies had taken options to purchase such lands for prices between $50 and $75 per acre; that Great Lakes Carbon Company purchased diatomite lands

generally for $50 per acre, but paid $75 per acre for 80 acres in Shasta County, California, in 1951; that National Silica Company sold 242 acres of diatomite lands to Wyndotte Chemical Company for $42.47 an acre in 1951; that an option to purchase 1,800 acres of such lands by Great Lakes Carbon Company in 1953 was for $75.00 per acre; that Eagle Picher Company took an option in 1953 to purchase such lands at $75 per acre; and that Great Lakes Carbon Company in 1954 took an option to purchase 200 acres of diatomite lands at $50 per acre.

Mr. Erich also learned in his investigations that royalties paid by plaintiff as consideration for leases of two tracts in the Quincy Basin were 15 and 30 cents per ton of finished products, and that such royalties in other places were paid at a rate from 50 cents to $1.00 per ton of finished products.

Mr. Erich concluded and testified that the fair market value of all plaintiff's lands described in findings 4, 5, and 6, was $29,625 in 1952; and that such market value in 1959 was $31,661. Mr. Erich testified that he based his evaluation on what had been paid for diatomite lands comparable to plaintiff's tracts, that is, what prices had been paid to farmers and other owners of such lands. It was his testimony that the high moisture content had always existed in plaintiff's deposits and had no effect on the market value of such lands.

CONCLUSION OF LAW

Upon the foregoing findings of fact, which are made a part of the judgment herein, the court concludes as a matter of law that plaintiff is entitled to recover and it is therefore adjudged and ordered that plaintiff recover of and from the United States the sum of thirty thousand dollars ($30,000), together with interest thereon as part of just compensation at the rate of 4 percent per annum from December 1, 1957, until date of payment.

APPENDIX B

UNITED STATES COURT OF CLAIMS

No. 298-58

KENITE CORPORATION, *Plaintiff*.

v.

THE UNITED STATES, *Defendant*.

Judgment

IT IS ADJUDGED AND ORDERED that plaintiff recover of and from the United States the sum of thirty thousand dollars ($30,000), together with interest thereon as part of just compensation at the rate of 4 percent per annum from December 1, 1957, until date of payment.

Filed and entered June 6, 1962.

APPENDIX C

UNITED STATES COURT OF CLAIMS

No. 298-58

KENITE CORPORATION, *Plaintiff*.

v.

THE UNITED STATES, *Defendant*.

Order

This case come before the court on its own motion pursuant to Rule 54(a) to correct the findings of the court in the decision entered herein on June 6, 1962. Upon consideration thereof,

IT IS ORDERED that the decision of the court entered herein on June 6, 1962, be and the same is amended to delete the sentence, "He had not had any previous experience as an appraiser of properties." which appears at lines 9 and 10 of finding of fact No. 108, at page 56 of the slip opinion.

Filed and entered July 12, 1962.

APPENDIX D

IN THE UNITED STATES COURT OF CLAIMS

298-58

KENITE CORPORATION

v.

THE UNITED STATES

Order

These cases come before the court on motions for rehearings, reconsideration, amendment of judgments or new trials under Rules 53 or 54 of the Rules of this court and, on consideration thereof,

IT IS ORDERED this third day of October, 1962, that said motions be and the same are overruled as follows:

* * *

298-58 Kenite Corporation, Plaintiff's and defendant's motions.

* * *

BY THE COURT

MARVIN JONES
Chief Judge